

# TARDEC

--- TECHNICAL REPORT ---

THE NATION'S LABORATORY FOR ADVANCED AUTOMOTIVE TECHNOLOGY

No. TR- 13751.



## Field Demonstration for P-D-680 Solvent Replacement (Part II)

May 1998

By Dr. In-Sik Rhee

WINNER OF THE 1995 PRESIDENTIAL AWARD FOR QUALITY

U.S. Army Tank-Automotive Research,  
Development, and Engineering Center  
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## 1. Background

Department of Defense (DOD) facilities have been and continue to experience problems using P-D-680, Dry Cleaning and Degreasing Solvent<sup>1</sup>, for their maintenance activities. Currently, numerous federal, state, and local regulations limit usage of P-D-680 as it is considered a hazardous waste, a flammable material, and a toxic substance<sup>2</sup>. To resolve this problem, each of the services has initiated efforts to minimize P-D-680 solvent usage and to replace P-D-680 solvents with substitutive materials that are less hazardous and have effective cleaning performance. Under the auspices of the Joint Services Working Group (JSWG) on the Minimization of Petroleum Distillate Solvents for Military Applications, the Fuels and Lubricants Technology Team of the Tank-Automotive and Armaments Research, Development, and Engineering Center (TARDEC) as the specification Preparing Activity for P-D-680 has been working to develop environmentally compliant solvent alternatives that meet military requirements. This program, resourced under the Defense Supply Center Richmond's HAZMIN Program, was divided into the following two Phases.

Phase I: Conduct user surveys for P-D-680 solvents and evaluate commercial alternative solvents

Phase II: Conduct field validation tests, and revise the P-D-680 specification

(a) Army and Air Force Applications

(b) Navy Aviation and Shipboard Applications

During 1994-1995, a P-D-680 user survey was completed to determine requirements and constraints for general purpose cleaning solvents to meet military needs. Based on the user survey, a new vision was established to resolve current P-D-680 problems and evaluate commercial candidate solvents as P-D-680 replacements. As a follow-up action, eighty-two

(82) solvent samples were evaluated and compared to P-D-680 solvents. It was found only petroleum distillate hydrocarbon solvents and terpene/hydrocarbon blended solvents met the current P-D-680 performance needs. Especially, terpene/hydrocarbon blended solvents gave excellent performance in all aspects of the laboratory testing requirements. Aqueous types of solvents and water based solvents were not applicable due to both their poor corrosion protection and solvency. Based on these test results, twenty-three (23) commercial solvents were selected as candidate alternative P-D-680 solvents. The test results were summarized in a TARDEC technical report<sup>3</sup> entitled "Replacement of P-D-680 Solvents for General Maintenance of DOD Equipment".

In concert with the Phase II portion of this initiatives, the first part of field demonstrations were initiated in 1996 at Army and Air Force installations to verify performance and environmental applicability of candidate solvents under a variety of field environments. Ft. Lewis WA was designated as a major field testing site for this demonstration and evaluated eight (8) candidate solvents in various military ground equipment (e.g., tactical vehicles), helicopter, and weapon cleaning applications. Ft. Hood evaluated two (2) different types of candidate solvents in helicopter maintenance applications. For Air Force applications, San Antonio Air Logistic Center at Kelly AFB TX evaluated four (4) candidate solvents using aviation equipment and ground support equipment. The test results were summarized in TARDEC technical report<sup>4</sup> entitled "Field Demonstration for P-D-680 Solvent Replacement". The following facts were found during the Army and Air Force field demonstrations.

- Severe hydrotreated odorless hydrocarbon solvents were very well accepted because of their low odor characteristics and less toxicity. Especially, the candidate Type II product is more favored than the Type III due to its faster drying time.
- Hydrotreated terpene/hydrocarbon blended solvents were also very well accepted in all applications. Citron odor was not considered as a major problem in open working areas.
- Odor, cleaning power, corrosion protection and toxicity of solvent were major evaluation selection factors for all cleaning applications.

- Most users did not like to continuously use hydrocarbon solvents having strong offensive odors (i.e., P-D-680 Types I and II odor).
- Odorless hydrotreated Type II hydrocarbon solvent was acceptable for weapon cleaning applications due to its odorless characteristics.
- All candidate solvents performed well for all applications when compared to P-D-680 solvents that have a strong hydrocarbon odor and medium level of toxicity (i.e., irritation to skin).
- Candidate Type II solvents were found to be acceptable when used in applications requiring Type I.
- Laboratory test results correlated well with field performance.
- Six candidate solvents among eight solvents tested were rated by users as acceptable replacements for P-D-680.

In 1997, the second part of field demonstrations was conducted at four (4) Navy installations to verify performance and environmental applicability of candidate solvents under a variety of Navy field environments. These candidate solvents have been also tested at the previous Army and Air Force field demonstrations. Naval Aviation Depot (NADEP), Cherry Point NC evaluated four (4) candidate solvents in various aviation and ground equipment (i.e., cargo aircraft, utility vehicles). Naval Air Warfare Center (NAWC), Patuxent River MD also evaluated a candidate solvent in various aircraft supporting equipment. For Naval Shipboard applications, Naval Surface Warfare Center (NSWC), Carderock Division MD evaluated a candidate solvent in a shipboard bearing application. Naval Station, Mayport FL also evaluated a candidate solvent in various shipboard engine and missile part cleaning applications.

The field demonstrations have been completed and data analyzed for each participating Navy installations. This report summarizes the results of field demonstrations and findings in the Navy materiel cleaning applications.

## 2. Field Demonstration Program

### Objective:

The main objectives of this field testing were (1) to verify performance (i.e., solvency, cleaning ability, compatibility) of candidate solvents in existing military equipment and, (2) to determine the environmental assessment for these candidate solvents (i.e., local/federal environmental laws, user safety). The successful completion of this demonstration would result the current P-D-680 solvents being replaced with environmentally friendly products.

### (b) Scope:

The second part of the field demonstration encompassed four (4) Navy sites; NADEP, Cheery Point NC, NAWC, Patuxent River MD, NSWC, Carderock Division MD and Naval Station, Mayport FL, and focused on solvent cleaning performance and potential environmental acceptability of candidate alternative P-D-680 solvents. By the field coordinators, two (2) petroleum based solvents and two (2) terpene/hydrocarbon blended solvents were selected as candidates for these cooperative field validation. To verify the performance of candidate solvents in the P-D-680 cleaning applications, the field demonstrations were performed using a wide variety of Navy aviation and shipboard equipment including weapon systems. Their performances were measured by comparing their cleaning effectiveness against P-D-680 solvents. The duration of this field test was designed for a three month evaluation period. The final acceptance of the candidate solvents would be based on the field testing evaluation and resultant findings generated.

### (c) Field Testing Solvents:

The four (4) candidate solvents identified in Table 1 were selected from the six environmentally complaint solvents accepted at the previous Army and Air Force field demonstrations. Two (2) petroleum based solvents were selected in order to make a comparison with the existing P-D-680 Types II and III solvents. The other two (2) products



were terpene/hydrocarbon blended solvents as a new proposed Type IV solvent under P-D-680. The laboratory test results are shown in Table 2 for these solvents along with the P-D-680 solvents. Also, the test methods used in this laboratory evaluation and the P-D-680 specification requirements are provided in Appendix A.

**(d) Field Testing Sites and Procedure:**

Tables 3-4 summarize field testing sites and solvents that were evaluated at each installation as well as identifying the cleaning procedure and equipment used. All maintenance shops listed in these Tables currently use the P-D-680 Types I and II solvents in various types of part washers.

- NADEP, Cherry Point NC evaluated four (4) candidate solvents in various Navy aviation and ground equipment (i.e., engine, bearings) at five (5) different types of repair/maintenance shops. The cleaning methods used in these shops were the manual/automatic cleaning procedures using recirculated parts washers, a spray buster, and a particle cleaning system.

- NAWC, Patuxent River MD evaluated a candidate solvent using IT-30 Parts washer and aircraft support equipment (i.e., compressor valves, pistons, bearings, etc.) .

- NSWC, Carderock Division MD also evaluated a candidate solvent using existing part washers in shipboard bearing cleaning applications.

- Naval Station, Mayport FL evaluated an odorless candidate solvent in Navy missile cleaning applications at several Shore Intermediate Maintenance Agent (SIMA) testing sites. The cleaning methods used in these shops were the manual cleaning procedure using IT-48 weapon cleaning system (i.e., recirculated parts washer).

(e) Schedule:

The following milestones were developed to conduct the field demonstration.

| <u>Milestone</u>  | <u>Completion Date</u> |
|---|------------------------|
| NADEP, Cherry Point<br>Testing set up and coordination      | 27-28 January 1997     |
| NSWC, Carderock Division<br>Testing set up and coordination | 10 February 1997       |
| Naval Station, Mayport<br>Testing set up and coordination   | 4 April 1997           |
| NAWC, Patuxent River<br>Testing set up and coordination     | 10 May 1997            |
| Field Test Initiation                                       | 1 June 1997            |
| In Progress Review at NAWC, Patuxent River                  | 23 July 1997           |
| In Progress Review at NSWC, Carderock Division              | 24 July 1997           |
| In Progress Review at NADEP, Cherry Point                   | 4 September 1997       |
| In Progress Review at Naval Station, Mayport                | 8 September 1997       |
| Field Test Completed  | 15 September 1997      |

(f) Data Collection:

All testing results and operator/user comments were recorded and tabulated using two (2) Solvent Evaluation Sheets (Appendix B). Data was reviewed and collected on a bi-weekly basis. The following performance characteristics were closely monitored at each testing site.

- The cleaning/soil-removal performance of candidate solvents were compared to existing P-D-680 solvents (e.g., takes longer, requires more solvents, leave residue, does not remove soil, etc.)

- Any material incompatibility was identified (e.g., softens plastics, elastomers, etc).

- Corrosion protection characteristics were evaluated (e.g., evidence of pitting, rust, discoloration, etc).

- Drying time was noted (i.e., solvent remains or evaporates, air-blow required, etc).

- Environmental assessment were determined (i.e., health and safety factors, operator acceptability, odor, etc).

(g) Data Evaluation Score System:

To effectively evaluate field data, a score system was developed based on a typical university grading system. Maximum score was designated as 100 points and divided evenly between solvent performance and environmental assessment. The acceptance criteria for the candidate solvents was established at a rating of 80 points or higher using the following Data Evaluation Score System.

Solvent Performance

50 points

(unacceptable to acceptable ranges)

- |  |         |
|--|---------|
| • Solvent Cleaning Power (i.e., excellent=15 points, poor= 3 points) | 3-15    |
| • Compatibility (i.e., Yes=zero, No=10 points)                       | 0 to 10 |
| • Drying time (i.e., fast=5 points, slow=1 point)                    | 1-5     |

- Corrosion (i.e., Yes=zero, No=10 points) 0 to 10
- Residue (i.e., Yes=zero, No=10 points) 0 to 10

#### Environmental Assessment

50 points

- Odor Characteristics (i.e., strong=5, milder=20, odorless or nice=25) 5-25
- Toxicity ( i.e., severe=5, less=20, no=25) 5-25

The degree of toxicity was measured based on worker skin irritation. It was divided into three categories and defined as follows;

- No toxicity: Solvent does not adversely affect user's skin irritation without wearing rubber gloves
- Less toxicity: Solvent does not adversely affect user's skin irritation with wearing rubber gloves.
- Severe toxicity: Solvent does adversely affect user's skin irritation with wearing rubber gloves.

#### Overall Rating System

|          |           |
|----------|-----------|
| 90 - 100 | excellent |
| 80 - 89  | good      |
| 70- 79   | average   |
| 0 - 69   | poor      |

#### (h) Points of Contact:

The following representatives from each installation were served as a field coordinator or monitor.

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### 3. Test Results

A summary of the field test results and user's comments is presented in Tables 5-7. The typical raw data sheets gathered from the field tests are provided in Appendix C. To analyze the data, each solvent was evaluated separately using the above described solvent cleaning performance and environmental assessment criteria, and the comments were converted to numerical system using the data evaluation score method. The final rating was derived based on the results of these field evaluations. Data obtained for each candidate solvent were generated from three (3) main Navy P-D-680 applications (i.e., shipboard equipment, aviation equipment, ground equipment) at four (4) different Navy installations. The cleaning methods used in this demonstration were the routine maintenance part cleaning procedures using IT-30/48 parts washers and other types of recirculated parts washers. For practical purposes, the field demonstration focused on solvency, drying time, compatibility, corrosion protection, residue, odor, and toxicity of candidate solvents. To validate the field data, a candidate solvent was tested at two different testing sites in NADEP, Cherry Point NC. Typically, an odorless candidate solvent (i.e., Breakthrough) was evaluated using the various of military equipment (i.e., aviation, shipboard, etc.) at all four (4) Navy installations. Representative photographs taken from the testing sites are provided in Appendix D.

In shipboard applications, a candidate solvent (i.e., Breakthrough) was tested at two (2) Navy installations. The NSWC bearing repair shop evaluated Breakthrough solvent using cartridge-type deep groove bearings coated with DOD-G-24508, Grease, High Performance, Multipurpose. For comparison purpose, a P-D-680 Type II solvent was also reevaluated using

the same bearing cleaning procedure. This solvent was originally formulated with petroleum distilled hydrocarbon and used for dry cleaning, spot, and stain removing, and for degreasing of component parts in maintenance activities. The test results showed that Breakthrough solvent is superior to P-D-680 Type II in cleaning shipboard bearings lubricated DOD-G-24508 grease. It was noted that P-D-680 solvent had a longer drying time, left a residue, and did not break-down the grease as quickly as the candidate solvent. In the previous Army and Air Force field demonstrations, it was also reported that P-D-680 Types I and II have an offensive odor and some toxicity. Because of these environmental deficiencies, P-D-680 Types I and II were evaluated as environmentally unfriendly solvent and rated as "poor solvents". The SIMA of Naval Station, Mayport FL also evaluated Breakthrough solvent using shipboard engine and missile components (i.e., MK 13 missile launcher, metal fitting, missile parts, diesel engine heads and parts, etc.). This maintenance shop uses P-D-680 Type I as a regular cleaning solvent. Recently, EPA defined P-D-680 Type I solvent as a hazardous material due to its low flash point and high volatile organic compound (VOC). For this reason, the SIMA is seeking a new environmentally complaint solvent to resolve the environmental deficiency of P-D-680 Type I. Based on the SIMA field demonstration, it was reported that Breakthrough is an acceptable solvent for the replacement of P-D-680 Type I in their shipboard applications because of its odorless characteristics and good cleaning performance. In addition, the drying time of Breakthrough (slower than Type I) was not considered as a major problem in this shop. In overall, this candidate solvent was very well accepted in both shipboard applications.

In aviation applications, three (3) candidate solvents (Breakthrough, Electron, 134 Hi-Solv) were tested at two (2) Navy installations. The NADEP, Cherry Point NC evaluated Electron and 134 Hi-Solv solvents at three (3) different types of aviation shops. Electron solvent was evaluated at two different maintenance shops; electric shop and a machine shop. Currently, the electric shop uses P-D-680 Type II solvent as a maintenance cleaning agent for aviation parts such as actuators, electric motors, generators, etc., while the machine shop uses P-D-680 Type I solvent for cleaning aircraft parts such as bearings. During the field demonstration, both maintenance shops used Electron solvent in their routine cleaning applications and compared

them to P-D-680 solvents. The users reported that Electron solvent fits very well in their cleaning applications and is more environmentally friendly solvent than P-D-680 solvents. Specially, its citron odor was favored over that of P-D-680 Type II solvent. No residue problem was observed. This candidate solvent is a highly hydrotreated hydrocarbon solvent containing small amounts of d-limon material ( $>20\%$ ) which is used to enhance solvency. In the previous Army and Air Force field demonstrations, this candidate solvent was also very well accepted in all military applications. The candidate solvent for P-D-680 Type III (i.e., 134 Hi-Solv) was also evaluated at Cryogenic shop of NADEP. Currently, this shop repairs engine fire bottles used in military aircrafts. The cleaning method used in this shop was a manual cleaning procedure using a heated solvent (i.e., P-D-680 Type II or commercial hydrocarbon solvent) and a recirculating parts washers. Due to its elevated temperature operation, this shop was seeking a high flash point solvent to meet a local environmental/safety regulation. For this application, we selected a candidate solvent of P-D-680 Type III that provides a high flash point and odorless characteristics. In this trial test, it was reported that the candidate solvent gave a satisfactory performance in their part cleaning applications. However, they noted that its drying time is too long when compared to P-D-680 Type II. Generally, P-D-680 Type III solvent has a high flash point ( $< 220^{\circ}\text{C}$ ) and provides a low evaporation rate due to its heavy molecular weight. For this reason, many military maintenance shops use P-D-680 Type III solvent with mechanical drying systems (i.e., compressed air, oven) to improve drying time. In the aircraft supporting equipment, NAWC, Paxtuxent River MD evaluated Breakthrough solvent using aircraft parts such as compressor valve, bearings, intake oil breathers, etc. Soils used in this demonstration were wide ranges of grease, oil, dirt and mud. The cleaning method used in this shop was a manual cleaning procedure using an IT-30 parts washer. It was reported that Breakthrough solvent was adequate to clean soils contaminated in various types of aviation parts. No corrosion and compatibility problems were reported.

In ground equipment applications, two (2) candidate solvents (i.e., Breakthrough, PF Degreaser) designated as Types II and IV were tested in NADEP ground support shop and



compared with P-D-680. These candidate solvents were somewhat hydrotreated in order to reduce toxic aromatic materials such as benzene that provides a strong solvency. The cleaning method used in this shop was the manual procedure using an IT-30 parts washer. The test results showed PF Degreaser demonstrated good cleaning ability in a wide variety of soils, especially heavily contaminated grease, hydraulic fluid, engine oils, tar, carbon deposits and waxes. In addition, its mild orange/citron smell was not considered a major problem area in the ground vehicle cleaning applications. Even though, Breakthrough solvent showed somewhat weaker solvency than PF Degreaser, most users defined Breakthrough as a user friendly solvent. Based on this test, the NADEP preferred to use terpene/hydrocarbon blended solvents due to its strong solvency and less toxicity. However, both solvents tested in ground equipment provided adequate solvent power and correlated with the laboratory evaluations. No corrosion, residue and compatibility problems were reported.

P-D-680 solvents are also widely used in the Instrument cleaning applications. To improve cleaning procedure, the aircraft hydraulic fluid laboratory of NADEP is seeking for an environmentally complaint solvent to be used in HIAC/ROYCO particle counters. Currently, this laboratory uses the filtered P-D-680 Type II solvent as a cleaning agent. Due to its natural sensitivity, the cleaning agent used in the particle counter must have a good solvency, fast drying capacity, and not leave any residue on the components. To meet these requirements, a candidate solvent (i.e., Breakthrough) was tested in this instrument. The test results showed that Breakthrough solvent provided an excellent cleaning performance and gave the fast evaporation after clean. No residue was observed. It appears that the odorless hydrotreated hydrocarbon solvent is a good replacement for P-D-680 Types I and II.

All candidate products are non-carcinogenic and do not contain any ingredients listed by EPCRA, CERCLA, and RCRA. Also, worker exposure is not regulated by OSHA. However, there is a new requirement for all new products entering the military supply system in that each is to be reviewed and given a Toxicity Clearance by the Center for Health Promotion and Preventative Medicine (CHPPM). To meet this new military requirement, we requested the

toxicity clearance on the candidate solvents including two (2) additional candidate solvents tested at the previous Army and Air Force field demonstrations. After reviewing the available data, CHPPM gave the toxicity clearance for all six (6) solvents. These toxicity clearances are provided in Appendix E.

Solvent recycling is common practice in many industries to reduce waste stream. A wide range of solvents is currently recycled using several different types of distillation techniques. During P-D-680 user survey conducted in Phase I within DOD, most military users expressed their concerns to the current disposal problems of P-D-680 solvents. Although a solvent recycling demonstration was not conducted in this study, most users observed the recirculation part washers significantly extended solvent useful life. It appears this system can reduce solvent waste stream and is a first step to resolve the environmental problems the military currently faces. In 1998, a solvent recycling study is planned for the P-D-680 complaint solvents using the various types of commercial solvent recycle units (i.e., vacuum distillation, filtration, etc.).

#### 4. Conclusions

On the basis of the work completed to date, the second part of field demonstrations was successfully completed at Navy installations. Odor, cleaning power, residue, corrosion protection and toxicity of solvent were major evaluation factors in all Navy P-D-680 applications. The following findings evolved during the field demonstrations.

- Severe hydrotreated odorless hydrocarbon solvents were very well accepted in all Navy P-D-680 applications because of their low odor characteristics and less toxicity. Especially, the candidate Type II product was more favored than the Type III due to its faster drying time.
- Hydrotreated terpene/hydrocarbon blended solvents were also very well accepted in all applications, especially ground supporting equipment, due to their excellent solvency. Citron

odor was not considered a major problem in open working areas.

- P-D-680 Type II solvent had a long drying time, strong offensive odor, left residue, and did not break-down the grease as quickly as the candidate solvent. For these reasons, most participants rejected the use of P-D-680 Types I and II solvents in their cleaning applications.
- Odorless hydrotreated Type II hydrocarbon solvent was acceptable for laboratory instrument cleaning applications due to its low odor characteristics and spotless cleaning performance.
- Candidate Type II solvents were found to be acceptable when used in applications requiring Type I.
- All candidate solvents performed well for all Navy applications and provided better performance than P-D-680 solvents. Also, the test results agreed with those obtained from Army/Air Force field demonstrations.
- The following four (4) candidate solvents were rated by users as acceptable replacements or substitutes for P-D-680.

| Type | Solvent composition       | Candidate P-D-680 Solvent |
|------|---------------------------|---------------------------|
| I    | Hydrocarbon               | Type II solvent           |
| II   | Hydrocarbon               | Breakthrough              |
| III  | Hydrocarbon               | 134 Hi-Solv               |
| IV*  | Terpene/Hydrocarbon Blend | Electron<br>PF            |

\*This is a proposed new Type for P-D-680 and its performance is equivalent to Type II.

Based on the DOD field demonstration, P-D-680 specification will be revised to accept new environmentally complaint solvents.

## References

1. Federal Specification P-D-680, Dry Cleaning and Degreasing Solvent, 29 October, 1992.
2. Connie Van Brocklin, "Replacement of P-D-680 for Army Ground Vehicle and equipment Applications", Letter Report 94-1, October, 1993.
3. In-Sik Rhee, Carlos Venez., Karen Von Bernewitz, "Replacement of P-D-680 Solvents for General Maintenance of DOD Equipment", TARDEC Technical Report No. 13643, September, 1995.
4. In-Sik Rhee, Carlos Venez, "Field Demonstration for P-D-680 Solvent Replacement", TARDEC Technical Report No. TR-13730, October, 1996.

**Table 1. Field Demonstration Solvents**

| Solvent      | Designated P-D-680 Type | Odor Characteristics |
|--------------|-------------------------|----------------------|
| Breakthrough | II                      | Odorless             |
| 134 Hi-Solv  | III                     | Odorless             |
| Electron     | IV*                     | Citrus               |
| PF           | IV                      | Citrus               |

\* Proposed new P-D-680 Solvent Type

Table 2. Laboratory Solvent Test Results

| Product Code  | Flash Point, °C | Distillation, °C |       | Kauri-Butanol value | Non-volatile residue, % | Aniline Point, °C | Odor     | VOC g/l | Evap %, @ 20 min. | Corrosion |         | Relative Solvency, % |
|---------------|-----------------|------------------|-------|---------------------|-------------------------|-------------------|----------|---------|-------------------|-----------|---------|----------------------|
|               |                 | I.B.P            | D.P   |                     |                         |                   |          |         |                   | Cu        | Fe      |                      |
| P-D-680 (I)   | 47.0            | 165.4            | 204.6 | 39                  | 0.1                     | 61.2              | strong   | 789.7   | 47.1              | 1a        | no rust | 94.7                 |
| P-D-680 (II)  | 63.0            | 182.8            | 206.7 | 32                  | 0.07                    | 73.1              | strong   | 785.8   | 22.8              | 1a        | no rust | 94.4                 |
| P-D-680 (III) | 93.3            | 223.4            | 269.0 | 31                  | 0.3                     | 76.1              | odorless | 823.2   | 4.6               | 1a        | no rust | 89.3                 |
| Breakthrough  | 65.5            | 184.0            | 211.7 | 27                  | 0.05                    | 84.0              | odorless | 770     | 25.9              | 1b        | no rust | 87.6                 |
| 134 Hi-Solv   | 97.8            | 232.4            | 299.3 | 24                  | 0.07                    | 94.5              | odorless | 796     | 3.8               | 1b        | no rust | 80.7                 |
| Electron      | 63.9            | 191.8            | 235.6 | 32                  | 0.01                    | 69.1              | citrus   | 782     | 18.1              | 1b        | no rust | 87.8                 |
| PF            | 62.2            | 187.0            | 228.8 | 26                  | 0.32                    | 76.7              | citrus   | 760     | 14.8              | 1b        | no rust | 92.3                 |

Table 3. Field Testing Sites for P-D-680 Replacement Solvent at NADEP, Cherry Point

| Field Testing Site | Location   | Candidate Solvents                   | Designated Type to P-D-680 | Military Equipment                                   | Cleaning Method  | Specified Cleaning Solvent                    |
|--------------------|--|--------------------------------------|----------------------------|--|--|---|
| CPT-1              | Shop:6.2.94105,<br>Electric POC:Doug Blady or Kerry Jenkins          | Electron (Terpene/Hydrocarbon Blend) | IV*                        | Aviation electric generator parts                    | Remove grease/oil using hand cleaning procedure and a spray buster   | P-D-680 Type II supplied by DSCR              |
| CPT-2              | Shop:6.2.94104,<br>Cryogenics POC:Gren Patterson                     | 134 Hi-Solv (Hydrocarbon)            | III                        | Fire extinguisher bottles and parts                  | Remove grease/oil/fire residue using hand cleaning procedure and a parts washer                            | Formula 724 (previously used P-D-680 Type II) |
| CPT-3              | Shop:6.2.95541,<br>Aircraft/Hydraulic POC:Mickey Mashburn            | Breakthrough (Hydrocarbon)           | II                         | Particle counter for hydraulic fluids                | Remove oil/residue using particle counter cleaning procedure   | Filtered P-D-680 Type II supplied by DSCR     |
| CPT-4              | Shop:6.2.96114,<br>Ground Support POC:Dennis Ryan                    | PF (Terpene/Hydrocarbon Blend)       | IV                         | Ground support equipment including engines and parts | Remove grease/oil /carbon using hand cleaning procedure and IT-30 parts washer with edgeteck filter system | PF solvent (previously used P-D-680 Type II)  |
|                    |  | Breakthrough (Hydrocarbon)           | II                         |  |  |   |
| CPT-5              | Shop:6.2.93661,<br>Conventional Machine Manufacture POC:Tony Jenkins | Electron (Terpene/Hydrocarbon Blend) | IV                         | Aviation manufacture component and machine           | Remove grease/oil using hand cleaning procedure and a spray bottle or a small container                    | P-D-680 Type I supplied by DSCR               |

\* Proposed P-D-680 Type

Table 4. Field Testing Sites for P-D-680 Replacement Solvent at NSWC, NAWC, Maryport

| Field Testing Site       | Location  | Candidate Solvents            | Designated Type to P-D-680 | Military Equipment   | Cleaning Method   | Specified Cleaning Solvent                            |
|--------------------------|---|-------------------------------|----------------------------|--|---|---|
| NSWC, Carderock Division | Shop: Shipboard Bearing Repair Shop<br>POC: Gordon D. Huntzberry    | Breakthrough (Hydrocarbon)    | II                         | Shipboard groove bearings  | Remove grease/oil using hand cleaning procedure and a recirculating parts washer                          | P-D-680 Type II supplied by DSCR and Electron solvent |
|                          |   | P-D-680 Type II (Hydrocarbon) | II                         |  |   |   |
| Naval Station, Mayport   | Shop: 38B & 67E Ordnance Repair \$<br>Fire Control POC: ETCS Hodges | Breakthrough (Hydrocarbon)    | II                         | Shipboard engine and missile components (e.g., carburetor, air intake manifold)                    | Remove grease/oil using hand cleaning procedure and a IT-48 weapon cleaning system with edgeteck filter   | P-D-680 Type I supplied by DSCR                       |
| NAWC, Patuxent River     | Shop: Dyn Corp, FLEDS & Wells Maintenance POC: Don McLaurin         | Breakthrough (Hydrocarbon)    | II                         | Aircraft supporting equipment parts (i.e., compressor valve, bearings, intake oil breathers, etc.) | Remove grease/oil/carbon using hand cleaning procedure and IT-30 parts washer with edgeteck filter system | P-D-680 Type II supplied by DSCR                      |



Table 5. Field Test Results from NADEP, Cherry Point

| Field Testing Site | Candidate Solvent                              | Total Response | Military Equipment  | Comments  | CPP <sup>1</sup> | EAP <sup>2</sup> | Total Point | Ranking   |
|--------------------|--|----------------|---|---|------------------|------------------|-------------|-----------|
| CPT-1              | Electron<br>(Terpene/<br>Hydrocarbon<br>Blend) | 2              | Aviation electric<br>generators and<br>actuators                | <ul style="list-style-type: none"> <li>. Excellent solvency</li> <li>. Nice smell</li> <li>. No corrosion</li> <li>. Fast drying</li> <li>. No residue</li> <li>. Less toxic than P-D-680</li> <li>. Good performance</li> <li>. Acceptable solvent</li> </ul>      | 49               | 45               | 94          | Excellent |
|                    |  |                |   |   |                  |                  |             |           |
| CPT-2              | 134 Hi-Solv<br>(Hydrocarbon)                   | 2              | Fire extinguisher<br>bottles and parts<br>including<br>bearings | <ul style="list-style-type: none"> <li>. No odor</li> <li>. Good cleaning power</li> <li>. Slow drying</li> <li>. Low flammability</li> <li>. No corrosion</li> <li>. Acceptable solvent</li> </ul>   | 43               | 40               | 83          | Good      |
|                    |  |                |   |   |                  |                  |             |           |
| CPT-3              | Breakthrough<br>(Hydrocarbon)                  | 2              | Particle counter<br>for hydraulic<br>fluids                     | <ul style="list-style-type: none"> <li>. No odor</li> <li>. Excellent solvent</li> <li>. No corrosion</li> <li>. No irritation to skin</li> <li>. Fast drying</li> <li>. No residue</li> <li>. Prefer solvent than P-D-680</li> <li>. Acceptable solvent</li> </ul> | 50               | 45               | 95          | Excellent |

| Field Testing Site | Candidate Solvent                     | Total Response | Military Equipment   | Comments  | CPP <sup>1</sup> | EAP <sup>2</sup> | Total Point | Ranking   |
|--------------------|---------------------------------------|----------------|--|---|------------------|------------------|-------------|-----------|
| CPT-4              | PF (Terpene/ Hydrocarbon Blend)       | 2              | Ground support equipment including diesel engines and bearings | <ul style="list-style-type: none"> <li>. No odor problem</li> <li>. Good cleaning power</li> <li>. Normal drying</li> <li>. No irritation to skin</li> <li>. No corrosion</li> <li>. Acceptable solvent</li> </ul>                          | 45               | 45               | 90          | Excellent |
|                    | Breakthrough (Hydrocarbon)            | 2              |  | <ul style="list-style-type: none"> <li>. No odor</li> <li>. Good cleaning power</li> <li>. Less cleaning power than PF</li> <li>. No corrosion</li> <li>. No residue</li> <li>. Acceptable solvent</li> </ul>                               | 42               | 45               | 87          | Good      |
|                    | Electron (Terpene/ Hydrocarbon Blend) | 2              |  | <ul style="list-style-type: none"> <li>. Good cleaning power</li> <li>. Citron odor (better than P-D- 680 odor)</li> <li>. Slow evaporation</li> <li>. No irritation to skin</li> <li>. No residue</li> <li>. Acceptable solvent</li> </ul> | 44               | 45               | 89          | Good      |

1. Cleaning Performance Points      2. Environmental Assessment Points

Table 6. Field Test Results from NSW C, Carderock Division

| Field Testing Site | Candidate Solvent             | Total Response | Military Equipment        | Comments  | CPP <sup>1</sup> | EAP <sup>2</sup> | Total Point | Ranking   |
|--------------------|-------------------------------|----------------|---------------------------|---|------------------|------------------|-------------|-----------|
| NSWC               | Breakthrough (Hydrocarbon)    | 5              | Shipboard groove bearings | <ul style="list-style-type: none"> <li>. Excellent solvency</li> <li>. No odor</li> <li>. No corrosion</li> <li>. Slow drying</li> <li>. No residue</li> <li>. No irritation to skin</li> <li>. Good performance</li> <li>. Acceptable solvent</li> </ul> | 48               | 45               | 93          | Excellent |
|                    | P-D-680 Type II (Hydrocarbon) | 5              |                           | <ul style="list-style-type: none"> <li>. Strong kerosene odor</li> <li>. Good cleaning power</li> <li>. Slow drying</li> <li>. Residue problem</li> <li>. No corrosion</li> <li>. Irritation to skin</li> <li>. Acceptable solvent</li> </ul>             | 34               | 25               | 59          | Poor      |

1. Cleaning Performance Points      2. Environmental Assessment Points

Table 7. Field Test Results from NAWC, Patuxent River and Naval Station, Mayport

| Field Testing Site | Candidate Solvent          | Total Response | Military Equipment   | Comments   | CPP <sup>1</sup> | EAP <sup>2</sup> | Total Point | Ranking   |
|--------------------|----------------------------|----------------|--|--|------------------|------------------|-------------|-----------|
| NAWC               | Breakthrough (Hydrocarbon) | 2              | Aircraft supporting equipment, compressor valves, intake oil breathers, bearings, housings and grease fittings, etc. | <ul style="list-style-type: none"> <li>. Good solvency</li> <li>. No odor</li> <li>. No corrosion</li> <li>. Fast drying</li> <li>. No residue</li> <li>. No irritation to skin</li> <li>. Good performance</li> <li>. Acceptable solvent</li> </ul>                         | 46               | 45               | 91          | Excellent |
| Mayport            | Breakthrough (Hydrocarbon) | 8              | Mk13 missile launcher, metal fitting, missile parts, engine heads and parts, air intake manifold, carburetors, etc.  | <ul style="list-style-type: none"> <li>. Mild odor to no odor</li> <li>. Good cleaning power</li> <li>. Normal drying</li> <li>. No residue</li> <li>. No corrosion</li> <li>. No Irritation to skin</li> <li>. Better than P-D-680</li> <li>. Acceptable solvent</li> </ul> | 41               | 42               | 83          | Good      |

1. Cleaning Performance Points      2. Environmental Assessment Points

# Appendices

## Appendix A-1. Test Protocol for Alternative P-D-680 Solvents

| Test                        | Method                |
|-----------------------------|-----------------------|
| Flash point                 | ASTM D 56             |
| Distillation                | ASTM D 86             |
| Kauri-Butanol value         | ASTM D 1133           |
| Aniline point               | ASTM D 611            |
| Odor                        | ASTM D 1298           |
| Non-volatile residue        | TGA*                  |
| Evaporation @ 50 °C, 20 min | TGA                   |
| Copper corrosion            | ASTM D 130            |
| Steel corrosion             | Modified ASTM D 130   |
| VOC content                 | EPA method 24         |
| Relative solvency           | Army soil test method |

\* Thermogravimetric Analysis

## Appendix A-2. P-D-680 Specification Requirements

| CHARACTERISTICS  | TYPE I                        | TYPE II                       | TYPE III           |
|--|-------------------------------|-------------------------------|--------------------|
| Flash point, °C, min   | 38.0 (100 °F)                 | 60.0 (140 °F)                 | 93.3 (200 °F)      |
| Distillation, °C:  |                               |                               |                    |
| Initial boiling pt., min   | 149                           | 177                           | 220                |
| 50 % recovered   | Report                        | Report                        | Report             |
| Dry point, °C, max   | 208                           | 211                           | 295                |
| Aniline point, °C  | 57 to 74                      | 57 to 74                      | 73 to 89           |
| Kauri-butanol value  | 29 to 45                      | 29 to 45                      | 27 to 45           |
| Allowable constituents, (% by volume): 1/  |                               |                               |                    |
| (a) Solvent with olefinic or cyclo-olefinic unsaturation, max                    | 5                             | 5                             | 0.8                |
| (b) Aromatic compounds with eight or more carbon atoms, except ethylbenzene, max | 8                             | 8                             | 0.8                |
| (c) Total of ethylbenzene, toluene, and branched chain ketones, max              | 20                            | 20                            | 1                  |
| (d) Total of (a) + (b) + (c), max  | 20                            | 20                            | 1                  |
| Total chlorine content (ppm) max   | 100                           | 100                           | 100                |
| Apparent specific gravity  | 0.754 to 0.820                | 0.754 to 0.820                | 0.740 to 0.840     |
| Non-volatile residue (mg/100 mL), max  | 10                            | 10                            | 10                 |
| Color, min   | 25                            | 25                            | 30                 |
| Odor 2/  | Characteristic & non-residual | Characteristic & non-residual | Low & non-residual |
| Corrosion, copper, max 3/  | 2A                            | 2A                            | 2A                 |
| Acidity  | neutral                       | neutral                       | neutral            |
| Doctor test  | negative                      | negative                      | negative           |
| Vapor pressure, Torr @ 20 °C, max  | -                             | -                             | 0.40               |
| Total phenol content (ppm), max  | 0.5                           | 0.5                           | 0.5                |
| Viscosity, cSt at 25 °C, max   | -                             | -                             | 5.0                |

1/ These maximum limits are as defined in Rule 102, South Coast Air Quality Management District regulations.

## Appendix B. Solvent Evaluation Sheets



# SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

## 1. USER CATEGORY

What class of materiel is cleaned by P-D-680 solvents?  
(e.g., weapons, artillery, armored, tactical vehicles, combat service support, aircrafts, ships, bearings, etc...)

What is your organization and installation?

Please provide your name, title, address and phone number:

## 2. EVALUATION OF CURRENT P-D-680 SOLVENTS

What types of P-D-680 solvents are you currently using to clean weapons, vehicles, or other equipment? (e.g., types 1, 2, or 3)

Are you currently using other than P-D-680 solvents?

What problems have you experienced with current P-D-680 solvents?

What do you like about current P-D-680 solvents?

What don't you like about current P-D-680 solvents?

What type of P-D-680 solvents do you like that fit your applications?

### 3. EVALUATING ALTERNATIVE P-D-680 SOLVENTS

Name of solvent:

What type of cleaning method(s) did you use to evaluate this solvent? (short description)

What types of equipment or parts were used to evaluate this solvent?

What is your opinion on the solvency (i.e., cleaning characteristics) of this solvent? (e.g., excellent, good, average, poor)

What is your rating as to its drying time or how quickly did it evaporate? (e.g., fast, normal, slow)?

Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent? (e.g., pitting, rust,...etc.)

Did you observe any in compatibility problem between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed,... etc.)

Did you smell any odor? If so, describe what type of odor and the degree of odor. (e.g., strong, mild, odorless, ...etc.)

When compared this solvent with P-D-680, which product is better fitted for your applications?

Overall, what rating would you give for this solvent? (accept, or reject)

#### 4. HEALTH, SAFETY OF ALTERNATIVE P-D-680 SOLVENT

Have you, or did you have knowledge of others that may have experienced nausea, skin rashes, or other adverse effects from use of this alternative P-D-680 solvent? Discuss.

Did you have problems in disposing of this alternative P-D-680 solvent that you tested?

Did you see any possible flammability problems with using this solvent?

5. SPEAK OUT!

Please discuss anything else pertaining to tested solvent that you would like to voice, especially comments and suggestions for the development of an improved cleaning product?

6. This solvent evaluation sheet should be returned as soon as possible after completion of field test:

DEPARTMENT OF THE ARMY  
MOBILITY TECHNOLOGY CENTER - BELVOIR  
ATTN AMSTA RBF (MR I RHEE)  
10115 Gridely Rd STE 128  
FORT BELVOIR, VA 22060-5843

Questions may be directed to:

Mr. In-Sik Rhee Fuels and Lubricants Technology Team  
Telephone: (703) 704-1824 or DSN 654-1824  
Fax: (703) 704-1822

## Solvent Evaluation Sheet for P-D-680 Replacements

Date: \_\_\_\_\_

Name: \_\_\_\_\_

Activity name: \_\_\_\_\_

Type of Part Cleaned (e.g., bearings, aviation engines): \_\_\_\_\_

Test solvent: \_\_\_\_\_

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

5                      4                      3                      2                      1  
Heavily soiled-----moderately soiled-----lightly soiled

2. What type(s) of soils are removed from the parts? (circle all that apply)

Grease   Oil                      Dirt                      Mud                      Other (describe) \_\_\_\_\_

3. How do you rate the cleaning power of this solvent?

Excellent                      Good                      Average                      Fair                      Poor

4. What is your rating as to its drying time or how quickly did it evaporate?

Very fast                      Fast                      Normal                      Slow                      Too slow

5. Did you observe any corrosion forming on the surface of cleaned parts due to the solvent?

Yes                                      No

6. Did you observe any incompatibility between this solvents and parts? (e.g., softened plastic materials, elastomer shrinking or swelling, coating being removed, etc.)

Yes                                      No

7. Did you observe any residue on the parts after using this solvent?

Yes                                      No

8. Describe solvent odor?

Strong                      Mild                      Nice                      Less odor                      Odorless

9. Report any health problems experienced with this solvent.

Nausea                      Skin rashes                      Headache                      Eye irritation                      Other (please describe)

10. Overall, what rating would you give for this solvent?

Highly acceptable                      Acceptable                      Reject

Comments: \_\_\_\_\_

## Appendix C-1. Typical Field Data obtained from NADEP, Cherry Point

- Breakthrough
- Electron
- 134 Hi-Solv
- PF Degreaser

# Solvent Evaluation Sheet for P-D-680 Replacements

Date: 7-2-97

Name: PHILLIP SOLKEY

Activity name: NADEP Cherry Point, N.C.

Type of Part Cleaned (e.g., bearings, aviation engines): Aviation actuator  
of all kinds, electric motor windings

Test solvent: Electric or Electron (some-one removed the labels)

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

(5) 4 3 2 1  
Heavily soiled ————— moderately soiled ————— lightly soiled

2. What type(s) of soils are removed from the parts? (circle all that apply)

(Grease) (Oil) (Dirt) (Mud) Other (describe) RUST - ALUMINUM CORROSION

3. How do you rate the cleaning power of this solvent?

(Excellent) Good Average Fair Poor

4. What is your rating as to its drying time or how quickly did it evaporate? using high pressure air, some times we air dry, then place in the oven for a few seconds  
Very fast (Fast) Normal Slow Too slow

5. Did you observe any corrosion forming on the surface of cleaned parts due to the solvent?

Yes

(No)

6. Did you observe any incompatibility between this solvents and parts? (e.g., softened plastic materials, elastomer shrinking or swelling, coating being removed, etc.)

Yes

(No)

7. Did you observe any residue on the parts after using this solvent?

Yes

(No)

8. Describe solvent odor?

Strong

Mild

(Nice)

Less odor

Odorless

9. Report any health problems experienced with this solvent.

Nausea

Skin rashes

Headache

the hands Eye irritation

Other (please describe)

10. Overall, what rating would you give for this solvent?

(Highly acceptable)

Acceptable

Reject

Comments:

I like this solvent, clean it works well and removed all kinds of grease, oil from all kinds of metal.

# Solvent Evaluation Sheet for P-D-680 Replacements

Date: 6/24/97

Name: JAMES J SHANNON

Activity name: NADEP - GSE - 96114

Type of Part Cleaned (e.g., bearings, aviation engines): GSE ENGINE PARTS

Test solvent: Break through

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

5 4 3 2 1  
Heavily soiled ————— moderately soiled ————— lightly soiled

2. What type(s) of soils are removed from the parts? (circle all that apply)

Grease Oil Dirt Mud Other (describe) GREASE

3. How do you rate the cleaning power of this solvent?

Excellent Good Average Fair Poor

4. What is your rating as to its drying time or how quickly did it evaporate?

Very fast Fast Normal Slow Too slow

5. Did you observe any corrosion forming on the surface of cleaned parts due to the solvent?

Yes No

6. Did you observe any incompatibility between this solvents and parts? (e.g., softened plastic materials, elastomer shrinking or swelling, coating being removed, etc.)

Yes No

7. Did you observe any residue on the parts after using this solvent?

Yes No

8. Describe solvent odor?

Strong Mild Nice Less odor Odorless

9. Report any health problems experienced with this solvent.

Nausea Skin rashes Headache Eye irritation Other (please describe) DRIES OUT THE SKIN

10. Overall, what rating would you give for this solvent?

Highly acceptable Acceptable Reject

Comments: LESS CLEANING ABILITY  
MORE USER FRIENDLY



# Solvent Evaluation Sheet for P-D-680 Replacements

Date: 4-16-97  
Name: Dutch Zensenick  
Activity name: 62,96114  
Type of Part Cleaned (e.g., bearings, aviation engines): All Internal Diesel  
Engine parts bearings etc.  
Test solvent: DE Degreaser

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

5 4 3 2 1  
Heavily soiled ----- moderately soiled ----- lightly soiled

2. What type(s) of soils are removed from the parts? (circle all that apply)

Grease Oil Dirt Mud Other (describe) \_\_\_\_\_

3. How do you rate the cleaning power of this solvent?

Excellent Good Average Fair Poor

4. What is your rating as to its drying time or how quickly did it evaporate?

Very fast Fast Normal Slow Too slow

5. Did you observe any corrosion forming on the surface of cleaned parts due to the solvent?

Yes

No

6. Did you observe any incompatibility between this solvents and parts? (e.g., softened plastic materials, elastomer shrinking or swelling, coating being removed, etc.)

Yes

No

7. Did you observe any residue on the parts after using this solvent?

Yes

No

8. Describe solvent odor?

Strong

Mild

Nice

Less odor

Odorless

9. Report any health problems experienced with this solvent.

NONE

Nausea

Skin rashes

Headache

Eye irritation

Other (please describe)

10. Overall, what rating would you give for this solvent?

Highly acceptable

Acceptable

Reject

Comments: would much rather use Test solvent than P-D-680.

7165 JACAP  
64 WASHU

# Solvent Evaluation Sheet for P-D-680 Replacements

Date: 4-16-97  
Name: MICKEY MASHBURN  
Activity name: NADEP CHERRY PT.  
Type of Part Cleaned (e.g., bearings, aviation engines):  
PARTICLE COUNTERS  
Test solvent: BREAK THROUGH

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

5                      4                      3                      2                      1  
Heavily soiled                      moderately soiled                      lightly soiled

2. What type(s) of soils are removed from the parts? (circle all that apply)

Grease Oil                      Dirt                      Mud                      Other (describe) \_\_\_\_\_

3. How do you rate the cleaning power of this solvent?

Excellent                      Good                      Average                      Fair                      Poor

4. What is your rating as to its drying time or how quickly did it evaporate?

Very fast                      Fast                      Normal                      Slow                      Too slow

5. Did you observe any corrosion forming on the surface of cleaned parts due to the solvent?

Yes                      No

6. Did you observe any incompatibility between this solvents and parts? (e.g., softened plastic materials, elastomer shrinking or swelling, coating being removed, etc.)

Yes                      No

7. Did you observe any residue on the parts after using this solvent?

Yes                      No

8. Describe solvent odor?

Strong                      Mild                      Nice                      Less odor                      Odorless

9. Report any health problems experienced with this solvent.

Nausea                      Skin rashes                      Headache                      Eye irritation                      Other (please describe)

10. Overall, what rating would you give for this solvent?

Highly acceptable                      Acceptable                      Reject

Comments:

DOES EXCELLENT JOB on cleaning EQUIPMENT, work benches  
AND ALL AREAS in Lab.

# Solvent Evaluation Sheet for P-D-680 Replacements

Date: 5/9/97

Name: Tony Givestell

Activity name: 93661 Machine Manufacturing

Type of Part Cleaned (e.g., bearings, aviation engines): (Parts) Aircraft Grinding operations

Test solvent: Electron Dielectric Solvent

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

Heavily soiled 5 4 3 2 1  
moderately soiled lightly soiled

2. What type(s) of soils are removed from the parts? (circle all that apply)

Grease Oil Dirt Mud Other (describe) \_\_\_\_\_

3. How do you rate the cleaning power of this solvent?

Excellent Good Average Fair Poor

4. What is your rating as to its drying time or how quickly did it evaporate?

Very fast Fast Normal Slow Too slow

5. Did you observe any corrosion forming on the surface of cleaned parts due to the solvent?

Yes No

6. Did you observe any incompatibility between this solvents and parts? (e.g., softened plastic materials, elastomer shrinking or swelling, coating being removed, etc.)

Yes No

7. Did you observe any residue on the parts after using this solvent?

Yes No

8. Describe solvent odor?

Strong Mild Nice Less odor Odorless

9. Report any health problems experienced with this solvent.

Nausea Skin rashes Headache Eye irritation Other (please describe)

10. Overall, what rating would you give for this solvent?

Highly acceptable Acceptable Reject

Comments:

# Solvent Evaluation Sheet for P-D-680 Replacements

Date: 5/9/97

Name: Tony Gvestell

Activity name: 93661 Machine Manufacturing

Type of Part Cleaned (e.g., bearings, aviation engines): (Parts) Aircraft Grinding operations

Test solvent: Electron Dielectric Solvent

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

5 4 3 2 1  
Heavily soiled ----- moderately soiled ----- lightly soiled

2. What type(s) of soils are removed from the parts? (circle all that apply)

Grease Oil Dirt Mud Other (describe) \_\_\_\_\_

3. How do you rate the cleaning power of this solvent?

Excellent Good Average Fair Poor

4. What is your rating as to its drying time or how quickly did it evaporate?

Very fast Fast Normal Slow Too slow

5. Did you observe any corrosion forming on the surface of cleaned parts due to the solvent?

Yes No

6. Did you observe any incompatibility between this solvents and parts? (e.g., softened plastic materials, elastomer shrinking or swelling, coating being removed, etc.)

Yes No

7. Did you observe any residue on the parts after using this solvent?

Yes No

8. Describe solvent odor?

Strong Mild Nice Less odor Odorless

9. Report any health problems experienced with this solvent

Nausea Skin rashes Headache Eye irritation Other (please describe)

10. Overall, what rating would you give for this solvent?

Highly acceptable Acceptable Reject

Comments:

# Solvent Evaluation Sheet for P-D-680 Replacements

Date: 7-2-97

Name: GLEN PATTERSON

Activity name: CRYOGENICS

Type of Part Cleaned (e.g., bearings, aviation engines): ENGINE FIRE BOTTLES

Test solvent: Hi-Solv 13C

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

5                      4                      3                      2                      1  
Heavily soiled                      moderately soiled                      lightly soiled

2. What type(s) of soils are removed from the parts? (circle all that apply)

Grease Oil                      Dirt                      Mud                      Other (describe) \_\_\_\_\_

3. How do you rate the cleaning power of this solvent?

Excellent                      Good                      Average                      Fair                      Poor

4. What is your rating as to its drying time or how quickly did it evaporate?

Very fast                      Fast                      Normal                      Slow                      Too slow

5. Did you observe any corrosion forming on the surface of cleaned parts due to the solvent?

Yes                      No

6. Did you observe any incompatibility between this solvents and parts? (e.g., softened plastic materials, elastomer shrinking or swelling, coating being removed, etc.)

Yes                      No

7. Did you observe any residue on the parts after using this solvent?

Yes                      No

8. Describe solvent odor?

Strong                      Mild                      Nice                      Less odor                      Odorless

9. Report any health problems experienced with this solvent.

Nausea                      Skin rashes                      Headache                      Eye irritation                      Other (please describe)

10. Overall, what rating would you give for this solvent?

Highly acceptable                      Acceptable                      Reject

Comments:

# SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

## 1. USER CATEGORY

What class of materiel is cleaned by P-D-680 solvents?  
(e.g., weapons, artillery, armored, tactical vehicles, combat service support, aircrafts, ships, bearings, etc...)

Aircraft Components  
Engine Components (Aircraft and Ground Support)

What is your organization and installation?

Naval Aviation Depot  
Cherry Point, North Carolina

Please provide your name, title, address and phone number:

Jacqueline Grant, Chemist  
Naval Aviation Depot  
Materials Engineering, Code 4.3.4.2  
P.O. Box 8021  
Cherry Point, NC 28533-0021

## 2. EVALUATION OF CURRENT P-D-680 SOLVENTS

What types of P-D-680 solvents are you currently using to clean weapons, vehicles, or other equipment? (e.g., types 1, 2, or 3)

Type II

Are you currently using other than P-D-680 solvents?

PF Degreaser  
Formula 724

What problems have you experienced with current P-D-680 solvents?

Drying time and surface residue

What do you like about current P-D-680 solvents?

Ability to remove light oils

What don't you like about current P-D-680 solvents? --

Drying time and surface residue of the solvent which interferes with post rework operations.

What type of P-D-680 solvents do you like that fit your applications?

Type II and III

### 3. EVALUATING ALTERNATIVE P-D-680 SOLVENTS

Name of solvent:

134 Hi-Solv

Electron Dielectric

Breakthrough

PF Degreaser

What type of cleaning method(s) did you use to evaluate this solvent? (short description)

Solvents were evaluated in parts cleaners, spray booths, and solvent cans.

What types of equipment or parts were used to evaluate this solvent?

The type parts cleaned included engine fire bottles, actuators, Electric motors, internal diesel engine parts, bearings, etc.

What is your opinion on the solvency (i.e., cleaning characteristics) of this solvent? (e.g., excellent, good, average, poor)

The cleaning power of solvents tested ranged from excellent to average. The rating of solvent cleaning power was dependent on the type soil removed and the degree of soil contamination.

What is your rating as to its drying time or how quickly did it evaporate? (e.g., fast, normal, slow)?

Drying time was reported as too slow to very fast; the median point being normal. The fast drying report was the result of using high pressure air or a combination of air and oven drying.

Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent? (e.g., pitting, rust, ...etc.)

No visible surface corrosion was observed on the components once they were cleaned.

Did you observe any in compatibility problem between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed, ... etc.)

No incompatibility between solvent and parts cleaned were reported.

Did you smell any odor? If so, describe what type of odor and the degree of odor. (e.g., strong, mild, odorless, ...etc.)

Odor was reported as mild to none (odorless). It was also reported with some products as being a "nice" odor. The nice odor, associated with the type IV products, is dependent upon a given operator's sensitivity level to the orange or citrus scent.

When compared this solvent with P-D-680, which product is better fitted for your applications?

Candidate solvent Breakthrough, tested in the ground support area to clean heavily soiled components, did not receive a favorable report regarding cleaning power. All other candidate solvents were considered appropriate for the type of soil being removed at a given test site.

Overall, what rating would you give for this solvent? (accept, or reject)

All candidate solvents tested were accepted.

#### 4. HEALTH, SAFETY OF ALTERNATIVE P-D-680 SOLVENT

Have you, or did you have knowledge of others that may have experienced nausea, skin rashes, or other adverse effects from use of this alternative P-D-680 solvent? Discuss.

Minor skin irritation was reported with the use candidate solvents Breakthrough and Electron Dielectric

Did you have problems in disposing of this alternative P-D-680 solvent that you tested?

No problems were Reported Regarding disposal.

Did you see any possible flammability problems with using this solvent?

No flammability problems were reported



## 5. SPEAK OUT!

Please discuss anything else pertaining to tested solvent that you would like to voice, especially comments and suggestions for the development of an improved cleaning product?

All candidate solvents tested at the facility were rated acceptable. However, preference for use of the Type IV products was strongly declared. The type IV material was classified as having greater solvency in removing grease and oil from various metals most efficiently.

There was observed no difference in the drying time of the tested solvents from what is experienced using P-D-680 dry cleaning solvent.

It is suggested that several qualifying products be made available to allow for the selection of a solvent which is appropriate for one's cleaning application.

Suggested primary properties in developing an improved cleaning product are faster drying time and increased solvency.

6. This solvent evaluation sheet should be returned as soon as possible after completion of field test:

DEPARTMENT OF THE ARMY.  
MOBILITY TECHNOLOGY CENTER - BELVOIR  
ATTN AMSTA RBF (MR I RHEE)  
10115 Gridely Rd STE 128  
FORT BELVOIR, VA 22060-5843

Questions may be directed to:

Mr. In-Sik Rhee Fuels and Lubricants Technology Team  
Telephone: (703) 704-1824 or DSN 654-1824  
Fax: (703) 704-1822

## Appendix C-2. Typical Data obtained from NSWC, Carderock Division

- Breakthrough
- P-D-680 Type II

# Solvent Evaluation Sheet for P-D-680 Replacements

Date: 9 July 97

Name: Gordon D Huntzberry

Activity name: NSWC Cardiac Division

Type of Part Cleaned (e.g., bearings, aviation engines): Contridge Type Ball Bearing  
Serial # B16 Grease Rod - G-24508 (Henshell)

Test solvent: PD 680

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

5                      4                      3                      2                      1  
Heavily soiled-----moderately soiled-----lightly soiled

2. What type(s) of soils are removed from the parts? (circle all that apply)

Grease Oil                      Dirt                      Mud                      Other (describe) \_\_\_\_\_

3. How do you rate the cleaning power of this solvent?

Excellent                      Good                      Average                      Fair                      Poor

4. What is your rating as to its drying time or how quickly did it evaporate?

Very fast                      Fast                      Normal                      Slow                      Too slow

5. Did you observe any corrosion forming on the surface of cleaned parts due to the solvent?

Yes                      No

6. Did you observe any incompatibility between this solvents and parts? (e.g., softened plastic materials, elastomer shrinking or swelling, coating being removed, etc.)

Yes                      No

7. Did you observe any residue on the parts after using this solvent?

Yes                      No

8. Describe solvent odor?

Strong                      Mild                      Nice                      Less odor                      Odorless

9. Report any health problems experienced with this solvent.

Nausea                      Skin rashes                      Headache                      Eye irritation                      Other (please describe) None

10. Overall, what rating would you give for this solvent?

Highly acceptable                      Acceptable                      Reject

Comments: AFTER 2HR Bearing STILL Had oily Film on ALL parts  
needed To Be rinsed in another product To Remove Film,

# Solvent Evaluation Sheet for P-D-680 Replacements

Date: 11 July 97  
 Name: Gonda D Huntzberry  
 Activity name: NSW C CARDINAL Division  
 Type of Part Cleaned (e.g., bearings, aviation engines): Cartridge Type BALL Bearing  
Serial # F-733  
 Test solvent: Brexit Thane

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

5                      4                      3                      2                      1  
 Heavily soiled-----moderately soiled-----lightly soiled

2. What type(s) of soils are removed from the parts? (circle all that apply)

Grease Oil                      Dirt                      Mud                      Other (describe) \_\_\_\_\_

3. How do you rate the cleaning power of this solvent?

Excellent                      Good                      Average                      Fair                      Poor

4. What is your rating as to its drying time or how quickly did it evaporate?

Very fast                      Fast                      Normal                      Slow                      Too slow

5. Did you observe any corrosion forming on the surface of cleaned parts due to the solvent?

Yes                      No

6. Did you observe any incompatibility between this solvents and parts? (e.g., softened plastic materials, elastomer shrinking or swelling, coating being removed, etc.)

Yes                      No

7. Did you observe any residue on the parts after using this solvent?

~~Yes~~                      No

8. Describe solvent odor?

Strong                      Mild                      Nice                      Less odor                      Odorless

9. Report any health problems experienced with this solvent.

Nausea                      Skin rashes                      Headache                      Eye irritation                      Other (please describe) None

10. Overall, what rating would you give for this solvent?

Highly acceptable                      Acceptable                      Reject

Comments:

48  
45  
93

# NSWC Carderock Division

9500 MacAuthur Blvd  
Bldg 60 Code 642  
West Bethesda Md.20817-5700  
USA

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Phone 301-227-4792  
Fax 301-227-4789  
Email huntzber@metals.dt.navy.mil

July 25, 1997

Mary Wenzel  
Code 632  
West Bethesda, Maryland 20817-5700

## SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

### 1. USER CATEGORY:

A. The class of material being cleaned by the P-D-680 solvents were ball bearings. Type was a cartridge type deep groove bearing size 63312.

B. The name of our organization is NAVAL SURFACE WARFARE CENTER CARDEROCK DIVISION.

C. The information on the person conducting this evaluation is as follows:

Name: Gordon D. Huntzberry  
Title: Mechanical Engineering Tech.  
Address: 9500 MacAuthur Blvd  
Phone # 301-227-4792

### 2. EVALUATION OF CURRENT P-D-680 SOLVENTS

A. The type of P-D-680 used currently are TYPE II.

B. Yes, We also use a solvent called ELECTRON by Ecolink.

C. The problems I have experienced with the current P-D-680 are as follows: Slow drying, slow in the breaking down the grease in the test bearings, leaves heavy residue, and has strong odor.

D. If you are asking me what I like about the current P-D-680 Type II NOTHING. But if you are asking about the Break Through , that's a different story, It cleans fast, It removes grease much faster than the P-D-680, and has no odor.

E. I do not like the current P-D-680 because of the strong odor and the amount of time it takes to clean a bearing.

F. I would prefer the **Break Through** in our applications.

### 3. EVALUATING ALTERNATIVE P-D-680

A. **Break Through** would be an excellent replacement solvent.

B. Cleaning tank with electric motor and pump. We soak bearing for a short period of time and than we assisst the solvent with a brush, and rinse with a pressure hose.

C. I find break through to be an excellent cleaning material. It has excellent cleaning characteristics.

D. The drying time on the external parts were about 1 hour and the internal parts took a while longer.

E. I did not observe any type of corrosion forming on any of the parts with the break through.

F. I did not observe any compatibility problems.

G. The P-D-680 has a strong petroleum odor, and the **Break Through** has none.

H. If I had to select either P-D-680 or **Break Through**, I would have to choose the **Break Through**..

I. I would give the break through a rating of acceptable.

### 4. HEALTH,SAFETY, OF ALTERNATIVE P-D-680 SOLVENT

A. I have no knowledge of anyone experiencing adverse effects from **Break Through** solvent.

B. No , As long as we follow proper proceedures to dispose of the solvents.

C. No, I do not see any possible flammability problems eith this solvent.

### 5. SPEAK OUT

A. My personel feeling about P-D-680 is that it was a good solvent at one time, but I think it is time to move on to newer and safer solvent. I think that **Break Through** is an excellent replacement and should be considered.

### Appendix C-3. Typical Data obtained from NAWC, Paxtuxent River

- Breakthrough

## Solvent Evaluation Sheet for P-D-680 Replacement

Date: August 25, 1997

Name: Don McLaurin

Activity Name: FLEDS & Wells Maintenance

Type of parts cleaned: Compressor valves, intake oil breathers, bearings, cases, housings and grease fittings.

Type test solvent: Breakthrough

Circle the number or answer what best describes your response.

1. What was the condition of the part(s) you cleaned?

☒ 5 Heavily soiled      4      ☒ 3 moderately soiled      2      ☒ 1 Lightly soiled

2. What type(s) of soils are removed from the parts?

☒ Grease / oil      ☐ Dirt      ☐ Mud      Other (describe) \_\_\_\_\_

3. How do you rate the cleaning power of this solvent?

Excellent      ☒ Good      Average      Fair      Poor

4. What is your rating as to its drying time or how quickly did it evaporate?

Very fast      ☒ Fast      Normal      Slow      Too slow

5. Did you observe any corrosion forming on the surface of cleaned parts due to the solvent?

Yes      ☒ No

6. Did you observe any incompatibility between this solvent and the parts?

Yes      ☒ No

7. Did you observe any residue on the parts after using the solvent?

Yes      ☒ No

8. Describe solvent odor.

Strong      Mild      Nice      Less odor      ☒ odorless

9. Report any health problems experienced with this solvent

10. Nausea      Skin rashes      Headache      Eye irritation      ☒ Other: None

10. Overall, what rating would you give for this solvent?

☒ Highly acceptable      Acceptable      Reject



# SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

## 1. USER CATEGORY

What class of materiel is cleaned by P-D-680 solvents?  
(e.g., weapons, artillery, armored, tactical vehicles, combat service support, aircrafts, ships, bearings, etc...)

AIRCRAFT SUPPORT EQUIP.

What is your organization and installation?

DYN CORP  
NAS PATUXENT RIVER, MD

Please provide your name, title, address and phone number:

DON MCLAURIN LEADMAN (H) 301-994-0592  
PO BOX 38  
CALLAWAY, MD 20620 (W) 301-342-7989

## 2. EVALUATION OF CURRENT P-D-680 SOLVENTS

What types of P-D-680 solvents are you currently using to clean weapons, vehicles, or other equipment? (e.g., types 1, 2, or 3)

2

Are you currently using other than P-D-680 solvents?

NO

What problems have you experienced with current P-D-680 solvents?

SMELL AND SKIN IRRITATION

What do you like about current P-D-680 solvents?

Did you observe any in compatibility problem between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed,... etc.)

no

Did you smell any odor? If so, describe what type of odor and the degree of odor. (e.g., strong, mild, odorless, ...etc.)

no

When compared this solvent with P-D-680, which product is better fitted for your applications?

BREAKTHROUGH

Overall, what rating would you give for this solvent? (accept, or reject)

Accept

#### 4. HEALTH, SAFETY OF ALTERNATIVE P-D-680 SOLVENT

Have you, or did you have knowledge of others that may have experienced nausea, skin rashes, or other adverse effects from use of this alternative P-D-680 solvent? Discuss.

no

Did you have problems in disposing of this alternative P-D-680 solvent that you tested?

no

Did you see any possible flammability problems with using this solvent?

no

What don't you like about current P-D-680 solvents?

What type of P-D-680 solvents do you like that fit your applications?

### 3. EVALUATING ALTERNATIVE P-D-680 SOLVENTS

Name of solvent: *BREAKTHROUGH*

What type of cleaning method(s) did you use to evaluate this solvent? (short description)

*PARTS CLEANER*

What types of equipment or parts were used to evaluate this solvent?

*COMPRESSOR VALVES, PISTONS, BEARINGS ETC*

What is your opinion on the solvency (i.e., cleaning characteristics) of this solvent? (e.g., excellent, good, average, poor)

*Good*

What is your rating as to its drying time or how quickly did it evaporate? (e.g., fast, normal, slow)?

*FAST*

Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent? (e.g., pitting, rust,...etc.)

*No*

## FAX TRANSMITTAL

# of pages &gt; 5

|                         |  |
|-------------------------|--|
| To                      | From                                     |
| Dr. In-Sik Rhee         | ATC Anderson                             |
| Dept./Agency            | Phone #                                  |
|                         | 301 342 7982                             |
| Fax # 810-574-4123      | Fax #                                    |
| <del>703 704 1822</del> | 301 342 7684                             |
| N8N 7540-01-317-7368    | 5099-101 GENERAL SERVICES ADMINISTRATION |

## 5. SPEAK OUT!

Please discuss anything else pertaining to tested solvent that you would like to voice, especially comments and suggestions for the development of an improved cleaning product?

6. This solvent evaluation sheet should be returned as soon as possible after completion of field test:

DEPARTMENT OF THE ARMY  
MOBILITY TECHNOLOGY CENTER - BELVOIR  
ATTN AMSTA RBF (MR I RHEE)  
10115 Gridely Rd STE 128  
FORT BELVOIR, VA 22060-5843

Questions may be directed to:

Mr. In-Sik Rhee Fuels and Lubricants Technology Team  
Telephone: (703) 704-1824 or DSN 654-1824  
Fax: (703) 704-1822

810 574 4218

## Appendix C-4. Typical Data obtained from Naval Station, Mayport

- Breakthrough

# Solvent Evaluation Sheet for P-D-680 Replacements

Date: 7/7/97  
 Name: EMC(GW) REDMOND  
 Activity name: SIMA MAYPORT  
 Type of Part Cleaned (e.g., bearings, aviation engines): MK13 MISSILE LAUNCHER COVER PLATES  
 Test solvent: BREAK THROUGH

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

5                      4                      3                      2                      1  
 Heavily soiled                      moderately soiled                      lightly soiled

2. What type(s) of soils are removed from the parts? (circle all that apply)

Grease Oil                      Dirt                      Mud                      Other (describe) GLUE

3. How do you rate the cleaning power of this solvent?

Excellent                      Good                      Average                      Fair                      Poor

4. What is your rating as to its drying time or how quickly did it evaporate?

Very fast                      Fast                      Normal                      Slow                      Too slow

5. Did you observe any corrosion forming on the surface of cleaned parts due to the solvent?

Yes                      No

6. Did you observe any incompatibility between this solvents and parts? (e.g., softened plastic materials, elastomer shrinking or swelling, coating being removed, etc.)

Yes                      No

7. Did you observe any residue on the parts after using this solvent?

Yes                      No

8. Describe solvent odor?

Strong                      Mild                      Nice                      Less odor                      Odorless

9. Report any health problems experienced with this solvent.

Nausea                      Skin rashes                      Headache                      Eye irritation                      Other (please describe)

10. Overall, what rating would you give for this solvent?

Highly acceptable                      Acceptable                      Reject

Comments:

GOOD RESULTS, WE ARE HAPPY WITH THE NEW TANK AND THE SOLVENT SEEMS ADEQUATE.

45  
40  
85

# Solvent Evaluation Sheet for P-D-680 Replacements

Date: 6-19-97  
 Name: ARCENEAU, GMM  
 Activity name: SMA 38B  
 Type of Part Cleaned (e.g., bearings, aviation engines): METAL FITTINGS  
 Test solvent: BREAK THROUGH CLEANER COMP.

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

5                      4                      3                      2                      1  
 Heavily soiled-----moderately soiled-----lightly soiled

2. What type(s) of soils are removed from the parts? (circle all that apply)

Grease Oil                      Dirt                      Mud                      Other (describe) LIGHT RUST

3. How do you rate the cleaning power of this solvent?

Excellent                      Good                      Average                      Fair                      Poor

4. What is your rating as to its drying time or how quickly did it evaporate?

Very fast                      Fast                      Normal                      Slow                      Too slow

5. Did you observe any corrosion forming on the surface of cleaned parts due to the solvent?

Yes                      No

6. Did you observe any incompatibility between this solvents and parts? (e.g., softened plastic materials, elastomer shrinking or swelling, coating being removed, etc.)

Yes                      No

7. Did you observe any residue on the parts after using this solvent?

Yes                      No

8. Describe solvent odor?

Strong                      Mild                      Nice                      Less odor                      Odorless

9. Report any health problems experienced with this solvent.

Nausea                      Skin rashes                      Headache                      Eye irritation                      Other (please describe)

10. Overall, what rating would you give for this solvent?

Highly acceptable                      Acceptable                      Reject

Comments:

CT  
KO  
85

# Solvent Evaluation Sheet for P-D-680 Replacements

Date: 17 JUNE 97

Name: FURSNCKER

Activity name: Sima Mayport

Type of Part Cleaned (e.g., bearings, aviation engines): MK-13 MOD -4 HOIST (PAW1)

Test solvent: # BREAK THROUGH CLEANING COMP.

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

5 4 3 2 1  
Heavily soiled-----moderately soiled-----lightly soiled

2. What type(s) of soils are removed from the parts? (circle all that apply)

Grease Oil Dirt Mud Other (describe) PAINT chips

3. How do you rate the cleaning power of this solvent?

Excellent Good Average Fair Poor

4. What is your rating as to its drying time or how quickly did it evaporate?

Very fast Fast Normal Slow Too slow

5. Did you observe any corrosion forming on the surface of cleaned parts due to the solvent?

Yes

No

6. Did you observe any incompatibility between this solvents and parts? (e.g., softened plastic materials, elastomer shrinking or swelling, coating being removed, etc.)

Yes

No

7. Did you observe any residue on the parts after using this solvent?

Yes

No

8. Describe solvent odor?

Strong Mild Nice Less odor Odorless

9. Report any health problems experienced with this solvent.

Nausea Skin rashes Headache Eye irritation Other (please describe) NONE

10. Overall, what rating would you give for this solvent?

Highly acceptable Acceptable Reject

Comments: Power Brushes work very well, Good Lay out.



# Solvent Evaluation Sheet for P-D-680 Replacements

Date: 22 MAY 1997  
 Name: ENVILBY Cunningham  
 Activity name: SIMA 31E  
 Type of Part Cleaned (e.g., bearings, aviation engines):  
149 HERO  
 Test solvent: Break Through

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

5                      4                      3                      2                      1  
 Heavily soiled----- moderately soiled----- lightly soiled

2. What type(s) of soils are removed from the parts? (circle all that apply)

Grease Oil                      Dirt                      Mud                      Other (describe) CARBON

3. How do you rate the cleaning power of this solvent?

Excellent                      Good                      Average                      Fair                      Poor

4. What is your rating as to its drying time or how quickly did it evaporate?

Very fast                      Fast                      Normal                      Slow                      Too slow

5. Did you observe any corrosion forming on the surface of cleaned parts due to the solvent?

Yes                      No

6. Did you observe any incompatibility between this solvents and parts? (e.g., softened plastic materials, elastomer shrinking or swelling, coating being removed, etc.)

Yes                      No

7. Did you observe any residue on the parts after using this solvent?

Yes                      No

8. Describe solvent odor?

Strong                      Mild                      Nice                      Less odor                      Odorless

9. Report any health problems experienced with this solvent.

Nausea                      Skin rashes                      Headache                      Eye irritation                      Other (please describe)

10. Overall, what rating would you give for this solvent?

Highly acceptable                      Acceptable                      Reject

Comments: SOLUTION HAS NOT REALLY BEEN TESTED. THE REAL TEST IS WHEN A DEISEL OHL. IS BEING DONE.

32  
45  
77

# Solvent Evaluation Sheet for P-D-680 Replacements

Date: 5/22/97  
Name: Hidalgo Enrique  
Activity name: SIMA  
Type of Part Cleaned (e.g., bearings, aviation engines): Heads, parts  
Test solvent: Breakthrough

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

5                      4                      3                      2                      1  
Heavily soiled----- moderately soiled----- lightly soiled

2. What type(s) of soils are removed from the parts? (circle all that apply)

Grease Oil                      Dirt                      Mud                      Other (describe) \_\_\_\_\_

3. How do you rate the cleaning power of this solvent?

Excellent                      Good                      Average                      Fair                      Poor

4. What is your rating as to its drying time or how quickly did it evaporate?

Very fast                      Fast                      Normal                      Slow                      Too slow

5. Did you observe any corrosion forming on the surface of cleaned parts due to the solvent?

Yes                      No

6. Did you observe any incompatibility between this solvents and parts? (e.g., softened plastic materials, elastomer shrinking or swelling, coating being removed, etc.)

No                      No

7. Did you observe any residue on the parts after using this solvent?

Yes                      No

8. Describe solvent odor?

Strong                      Mild                      Nice                      Less odor                      Odorless

9. Report any health problems experienced with this solvent.

Nausea                      Skin rashes                      Headache                      Eye irritation                      Other (please describe) N/A

10. Overall, what rating would you give for this solvent?

Highly acceptable                      Acceptable                      Reject

Comments: works pretty good.

36  
45  
81

# Solvent Evaluation Sheet for P-D-680 Replacements

Date: 22 MAY 97  
 Name: STEVE BAWKS EN3  
 Activity name: SIMA MAYPORT  
 Type of Part Cleaned (e.g., bearings, aviation engines): AIR INTAKE MANIFOLD  
 Test solvent: BREAK THROUGH SOLVENT

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned ? (Circle the number that best describes your response)

☒ 5                      4                      3                      2                      1  
 Heavily soiled----- moderately soiled----- lightly soiled

2. What type(s) of soils are removed from the parts ? (circle all that apply)

Grease   Oil                      Dirt                      Mud                      ☒ Other (describe) CARBON

3. How do you rate the cleaning power of this solvent ?

Excellent                      ☒ Good                      Average                      Fair                      Poor

4. What is your rating as to its drying time or how quickly did it evaporate ?

Very fast                      ☒ Fast                      Normal                      Slow                      Too slow

5. Did you observe any corrosion forming on the surface of cleaned parts due to the solvent ?

Yes                      ☒ No

6. Did you observe any incompatibility between this solvents and parts ? (e.g., softened plastic materials, elastomer shrinking or swelling, coating being removed, etc.)

Yes                      ☒ No

7. Did you observe any residue on the parts after using this solvent ?

☒ Yes                      No

8. Describe solvent odor ?

Strong                      Mild                      Nice                      Less odor                      ☒ Odorless

9. Report any health problems experienced with this solvent.

Nausea                      Skin rashes                      Headache                      Eye irritation                      Other (please describe) N/A

10. Overall, what rating would you give for this solvent ?

Highly acceptable                      ☒ Acceptable                      Reject

Comments:

36  
 45  
 ---  
 81

# Solvent Evaluation Sheet for P-D-680 Replacements

Date: 22 MAY 97  
Name: DC COLLIER  
Activity name: SIMA Mayport  
Type of Part Cleaned (e.g., bearings, aviation engines): CARBURATION  
Test solvent: Breakthrough solvent

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

5      4      3      2      1  
Heavily soiled-----moderately soiled-----lightly soiled

2. What type(s) of soils are removed from the parts? (circle all that apply)

Grease Oil Dirt Mud Other (describe) \_\_\_\_\_

3. How do you rate the cleaning power of this solvent?

Excellent Good Average Fair Poor

4. What is your rating as to its drying time or how quickly did it evaporate?

Very fast Fast Normal Slow Too slow

5. Did you observe any corrosion forming on the surface of cleaned parts due to the solvent?

Yes

No

6. Did you observe any incompatibility between this solvents and parts? (e.g., softened plastic materials, elastomer shrinking or swelling, coating being removed, etc.)

Yes

No

7. Did you observe any residue on the parts after using this solvent?

Yes

No

8. Describe solvent odor?

Strong Mild Nice Less odor Odorless

9. Report any health problems experienced with this solvent.

Nausea Skin rashes Headache Eye irritation Other (please describe)

10. Overall, what rating would you give for this solvent?

Highly acceptable Acceptable Reject

Comments:

SOLVENT WORKS ABOUT THE SAME AS SAFETY KLEEN  
ALTHOUGH TANK DESIGN IS MUCH BETTER

# Solvent Evaluation Sheet for P-D-680 Replacements

Date: 6-12-97  
 Name: ADLENEAU GARY  
 Activity name: TSB SIMA  
 Type of Part Cleaned (e.g., bearings, aviation engines): MISSILE PARTS  
 Test solvent: BREAKTHROUGH CLEANING COMP.

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

5      4      3      2      1  
 Heavily soiled ----- moderately soiled ----- lightly soiled

2. What type(s) of soils are removed from the parts? (circle all that apply)

Grease   Oil      Dirt      Mud      Other (describe) \_\_\_\_\_

3. How do you rate the cleaning power of this solvent?

Excellent      Good      Average      Fair      Poor

4. What is your rating as to its drying time or how quickly did it evaporate?

Very fast      Fast      Normal      Slow      Too slow

5. Did you observe any corrosion forming on the surface of cleaned parts due to the solvent?

Yes

No

6. Did you observe any incompatibility between this solvents and parts? (e.g., softened plastic materials, elastomer shrinking or swelling, coating being removed, etc.)

Yes

No

7. Did you observe any residue on the parts after using this solvent?

Yes

No

8. Describe solvent odor?

Strong      Mild      Nice      Less odor      Odorless

9. Report any health problems experienced with this solvent.

Nausea      Skin rashes      Headache      Eye irritation      Other (please describe)

10. Overall, what rating would you give for this solvent?

Highly acceptable      Acceptable      Reject

Comments:

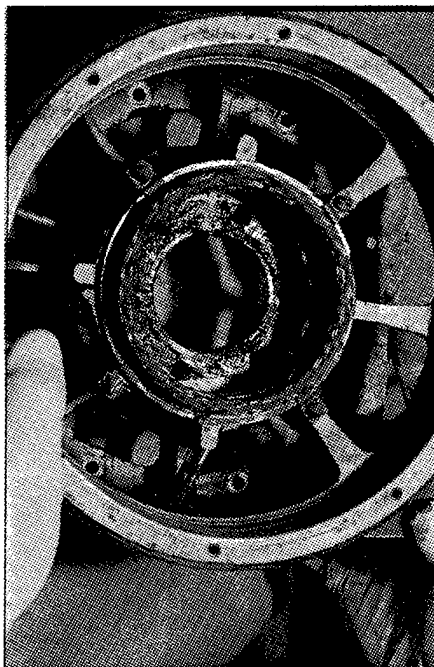
45  
60  
85

## Appendix D. Photos taken from Field Demonstration

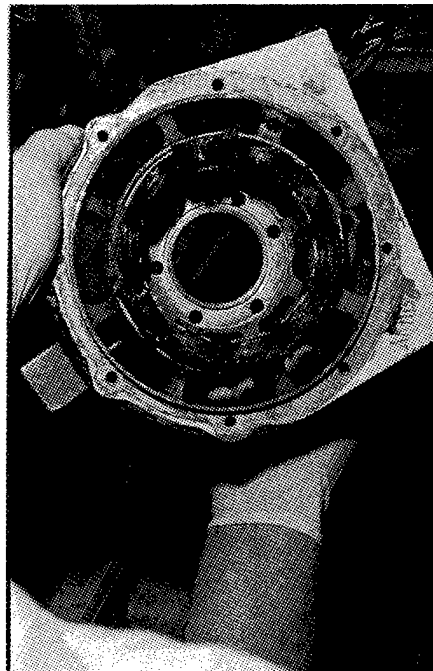
## NADEP, Cherry Point Field Demonstration



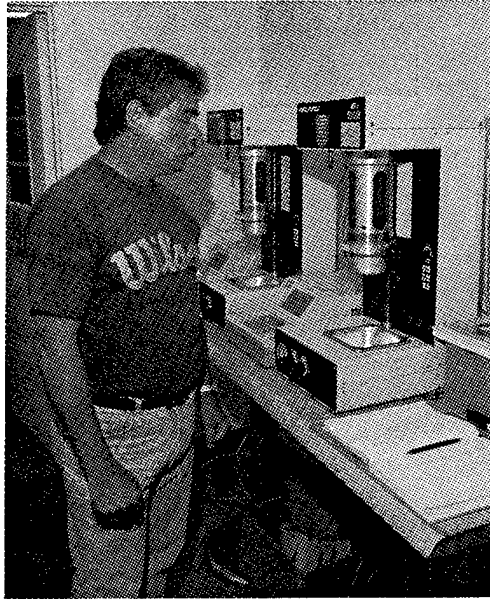
CH-46 Generator's Part, Being Cleaned Using a Spray Buster



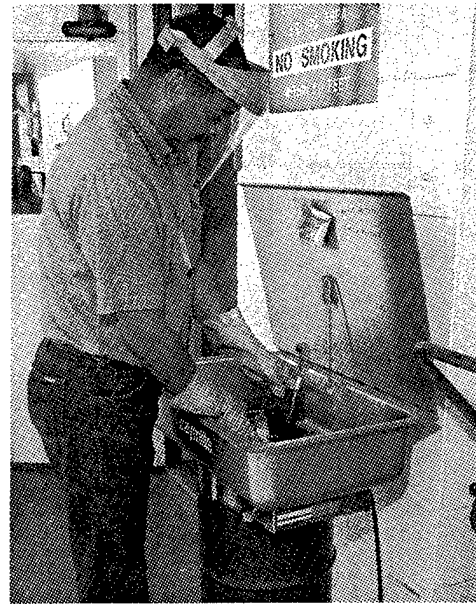
Before Cleaning (Starter Housing)



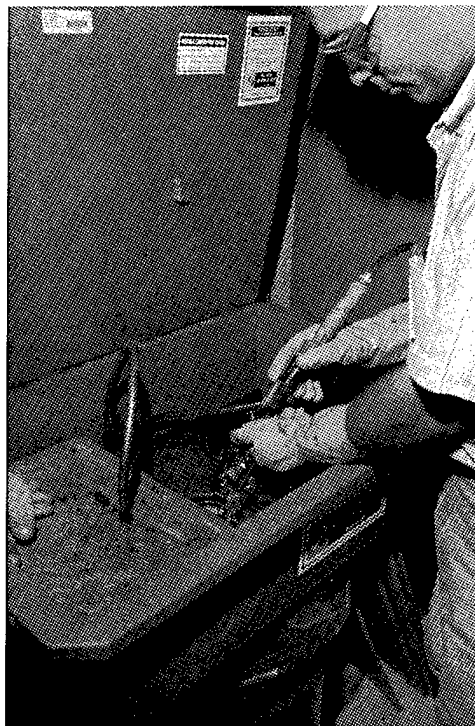
After Cleaning with Electron Solvent



Demonstration of Particle Counter at  
Aircraft Hydraulic Shop (Breakthrough)

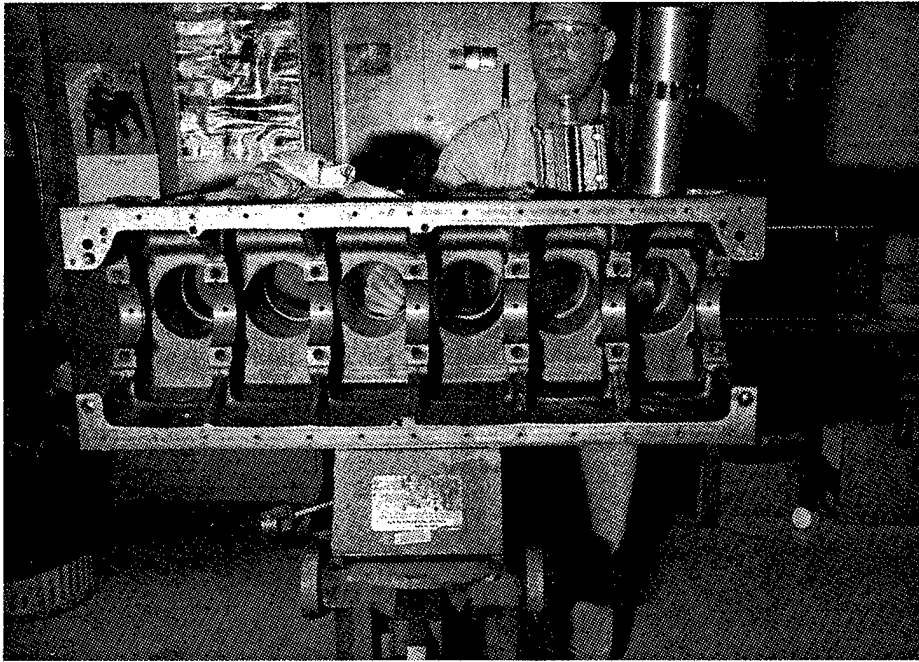


Aircraft Fire Extinguisher Container's Parts  
Being Cleaned at Cryogenics Shop  
(134 Hi-Solv)



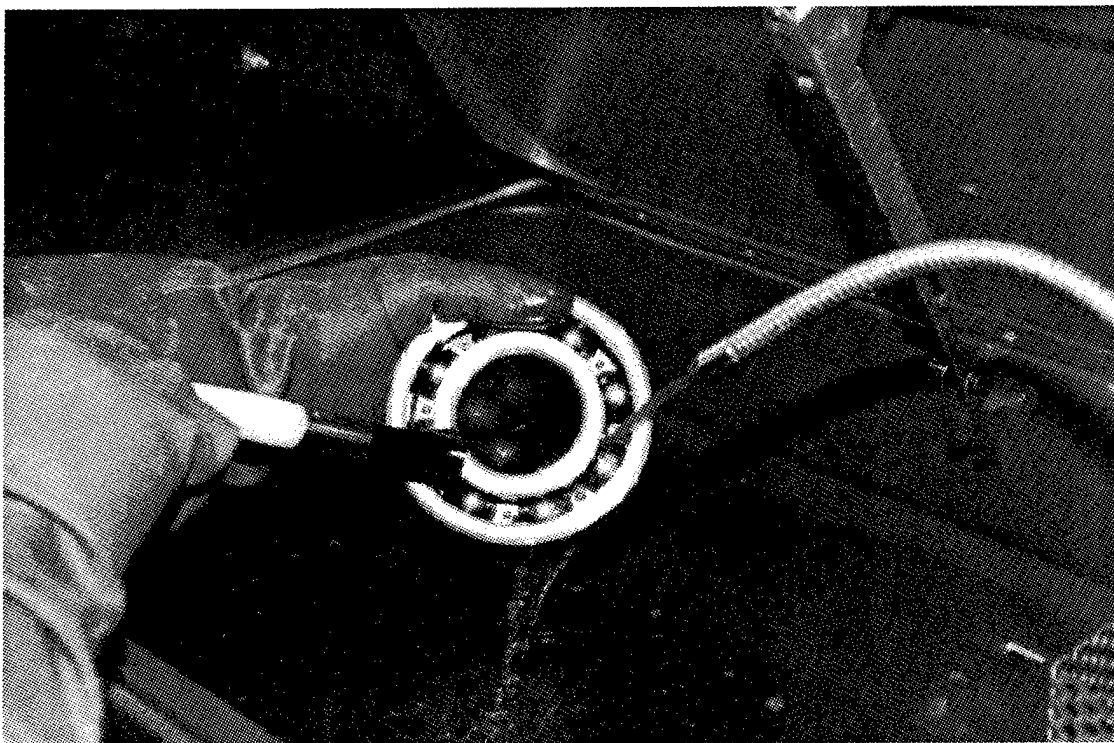
Tachometer Drive Adapter Being Cleaned at Ground Support Shop  
(Breakthrough PF Degreaser)





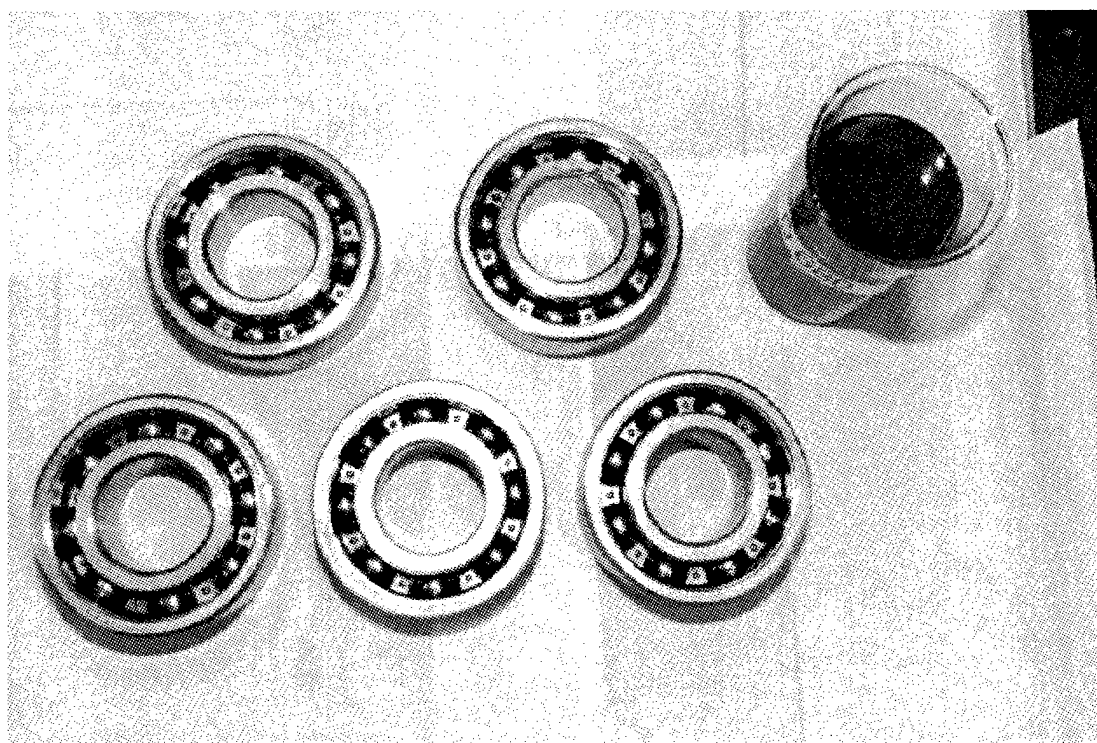
Engine Block Cleaned with PF Degreaser

## NSWC Field Demonstration



Shipboard Bearing Being Cleaned using a Recirculation Parts Washer

## Comparison Between P-D-680 Type II and a Candidate Solvent



Shipboard Bearing Cleaned with P-D-680 Type II - Demonstrates Residue Problem



Shipboard Bearing Cleaned with Breakthrough Solvent

## Naval Station, Mayport Field Demonstration



Missile Part Being Cleaned using IT-48 Parts Washer



Missile Parts Cleaned with Breakthrough Solvent

## NAWC Patuxent River Field Demonstration



Demonstration of Aircraft Part Cleaning Procedure using Breakthrough Solvent

## Appendix E. Toxicity Clearance for Candidate Solvent

- Breakthrough
- Electron
- 134 Hi-Solv
- PF Degreaser
- Skysol 100\*
- Skysol\*

\* Candidate Solvent for Army and Air Force Field Demonstration

MCHB-DC-TTE (AMSTA-RBF/ 28 Jan 97) 2d End Mr. Richard Angerhofer/vlk/AV 584-3980  
SUBJECT: Toxicity Clearance for P-D-680 Replacement Solvents

Commander, U.S. Army Center for Health Promotion and Preventive Medicine,  
Aberdeen Proving Ground, MD 21010-5422

FOR Commander, U.S. Army Materiel Command, 5001 Eisenhower Avenue,  
Alexandria, VA 22333-0001

1. Reference. Letter, Inland Technology, Inc., February 11, 1997, regarding Inland solvents, with enclosures therein.

2. Background.

a. The U.S. Army Mobility Technology Center - Belvoir has requested that this Center evaluate several solvents from a standpoint of toxicity. These solvents are intended to replace the more toxic and environmentally detrimental chemicals currently in use under Federal Specification P-D-680, "Dry Cleaning and Degreasing Solvent." This communication addresses three of the solvents for which toxicity clearances are being sought. The products to be covered herein are Breakthrough®, Skysol® and Skysol 100, Inland Technology Inc., Tacoma, WA. Future correspondence will cover two additional solvents mentioned in reference 1a.

b. Breakthrough is made up of C12 - C13 paraffinic hydrocarbons (100 % hydrotreated heavy petroleum naphtha) containing less than 0.01 % aromatics and no measurable amounts of halogenated hydrocarbon. The material is reported to be of low toxicity via the oral, dermal and inhalation routes; although slight skin and eye irritation may be expected upon contact (reference 1b). Breakthrough is neither listed as hazardous by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) nor the Resource Conservation and Recovery Act (RCRA).

c. Skysol and Skysol 100 are simply Breakthrough blended with Citra Safe®, <5% and <10%, respectively. Citra Safe is Inland Technology's brand of d-limonene, a naturally occurring chemical. D-limonene (monoterpene) is found in high concentrations in citrus fruits and, to some extent, in other fruits, vegetables, meats and food items. Citrus pulp and peels are used as the source of this chemical. The Environmental Protection Agency (EPA) does not view d-limonene as a hazardous material and has not imposed restrictive regulations on its use. The compound is also on the U. S. Food and Drug Administration's (FDA's) Generally Recognized as Safe (GRAS) List for flavoring and fragrance (ref 1b).

MCHB-DC-TTE

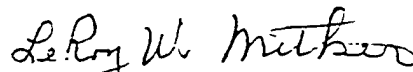
SUBJECT: Toxicity Clearance for P-D-680 Replacement Solvents

d. The three products have been used commercially for at least six years in both civilian and military solvent cleaning operations. These products are especially environmentally friendly in the fact that, when dirty, they can be filtered and reused, with the filter properly disposed of in the manner of a vehicle's oil filter (ref 1b).

3. Conclusion and Recommendation. Based upon the abundance of favorable toxicity, regulatory and use data; a toxicity clearance is granted for Breakthrough, Skysol and Skysol 100 for use as degreasing solvents conforming to Federal Specification P-D-680. Although no governmental or industrial exposure limits exist for the product components, all precautions for using and handling these products must be observed as per their Material Safety Data Sheets (MSDSs).

FOR THE COMMANDER:

Encl wd

  
LeROY W. METKER  
Program Manager, Toxicity Evaluation



MCHB-DC-TTE (AMSTA-RBF/ 22 Jan 97) (40-5e) 2d End Mr. Mark Michie/vlk/  
DSN 584-3980  
SUBJECT: Toxicity Clearance for P-D-680 Replacement Solvents

Commander, U.S. Army Center for Health Promotion and Preventive Medicine,  
Aberdeen Proving Ground, MD 21010-5422

FOR Commander, U.S. Army Materiel Command, 5001 Eisenhower Avenue,  
Alexandria, VA 22333-0001

1. References.

a. Letter, P-T Technologies, February 7, 1997, subject:, PF<sup>TM</sup> Solvent/Degreaser with enclosures therein.

b. Title 21, Code of Federal Regulations (CFR), Part 182.1033, citric acid.

2. Background.

a. The U.S. Army Mobility Technology Center - Belvoir has requested that this Center evaluate several solvents from a standpoint of toxicity. These solvents are intended to replace the more toxic and environmentally detrimental chemicals currently in use under Federal Specification P-D-680, "Dry Cleaning and Degreasing Solvent." This document addresses the use of PF<sup>TM</sup> Solvent/Degreaser, P-T Technologies, Safety Harbor, FL.

b. PF<sup>TM</sup> Solvent/Degreaser is a straight C chain non-halogenated hydrocarbon (C<sub>10</sub> - C<sub>13</sub>) with a small percentage of citrus terpene. The aliphatic hydrocarbon solvent is extremely pure with less than 0.001% aromatic content and is not classified as hazardous waste according to the Environmental Protection Agency/Toxic Characteristic Leaching Procedures regulations (reference 1b). The citrus terpene (d'Limonene) is a food grade additive and is found on the U.S. Food and Drug Administration's (FDA's) Generally Recognized as Safe (GRAS) list (reference 1c). The solvent contains no carcinogenic material and has a low oral toxicity, however ingestion of large quantities may cause nausea, vomiting and gastrointestinal irritation. Primary exposure is through skin and eye contact and inhalation. Repeated contact with the skin could cause defatting and dryness while inhalation may cause dizziness or headache.

c. PF<sup>TM</sup> Solvent/Degreaser has been used commercially for over 12 years, mainly in the power utility industry for cleaning cables, generators, turbines, without any adverse human health effects being reported. This product is also under contract with the General Services Administration (GSA) since June 1994 and has been used extensively by the U.S. Navy for hydraulic, weaponry, and aircraft engine cleaning, as a replacement for P-D-680 cleaners.

MCHB-DC-TTE

SUBJECT: Toxicity Clearance for P-D-680 Replacement Solvents

3. Conclusion and Recommendation. Based upon the abundance of favorable toxicity, regulatory and historical use data, a toxicity clearance is granted for PF™ Solvent/Degreaser for use as a degreasing solvent conforming to Federal Specification P-D-680. Although no governmental or industrial exposure limits exist for the product, the precautions for using and handling this product as per the Material Safety Data Sheet (MSDS) must be observed.

FOR THE COMMANDER:

Encl wd

*L Roy W. Metker*  
LeROY W. METKER  
Program Manager, Toxicity Evaluation

MCHB-DC-TTE (AMSTA-RBF/ 28 Jan 97) 2d End Mr. John Houpt/vlk/AV 584-3980  
SUBJECT: Toxicity Clearance for P-D-680 Replacement Solvents

Commander, U.S. Army Center for Health Promotion and Preventive Medicine,  
Aberdeen Proving Ground, MD 21010-5422

FOR Commander, U.S. Army Materiel Command, 5001 Eisenhower Avenue,  
Alexandria, VA 22333-0001

1. Reference.

- a. Memorandum, this Center, 22 January 1997, from Mobility Technology Center - Belvoir, subject: Toxicity Clearance for P-D-680 Replacement Solvents.
- b. Letter, Bio-Tek Solvents, Inc., February 6, 1997, regarding 134 Hi-Solv with enclosures therein.
- c. Letter, Bio-Tek Solvents, Inc., February 10, 1997, regarding 134 Hi-Solv.

2. Background.

- a. The U.S. Army Mobility Technology Center - Belvoir has requested that this Center evaluate several solvents from a standpoint of toxicity. These solvents are intended to replace the more toxic and environmentally detrimental chemicals currently in use under Federal Specification P-D-680, "Dry Cleaning and Degreasing Solvent." This communication addresses 134 Hi-Solv for which a toxicity clearance is being sought.
- b. 134 Hi-Solv is a blend of hydrocarbon solvents produced by Bio-Tek Solvents, Inc. and is a solvent cleaner/degreaser. Technical data provided by the supplier indicates this solvent is non-carcinogenic, odorless, biodegradable and requires no special handling, storage or disposal. According to Bio-Tek Solvents, it is safe for use in confined spaces and may be used for cleaning baking ovens and other food handling equipment. Slight skin and eye irritation may be expected upon overexposure and prolonged exposure to skin may lead to defatting (ref 1b).
- c. The Occupational Safety and Health Administration (OSHA) has not established a Permissible Exposure Limit (PEL) for the components of 134 Hi-Solv. Likewise, no Threshold Limit Value (TLV) has been offered by the American Conference of Government Industrial Hygienists (ACGIH). Bio-Tek Solvents recommends a TLV of 500 ppm.
- d. This product was developed for the US Navy and has been in use approximately 15 years in military solvent cleaning operations. There have been no known reports of adverse health effects from the use or manufacture of this product (ref 1c).

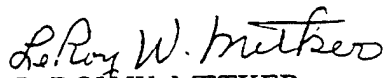
MCHB-DC-TTE

SUBJECT: Toxicity Clearance for P-D-680 Replacement Solvents

3. Conclusion and Recommendation. Based upon safe historical use, a review of the material safety data sheet and technical data provided by Bio-Tek Solvents, Inc., a toxicity clearance is granted for 134 Hi-Solv for use as a degreasing solvent conforming to Federal Specification P-D-680. All precautions for using and handling this product must be observed as per the Material Safety Data Sheet (MSDS). Adequate ventilation should be used in order to maintain concentrations below the recommended exposure limit. In addition, eye protection and gloves should be worn when using 134 Hi-Solv.

FOR THE COMMANDER:

Encl wd

  
LeROY W. METKER  
Program Manager, Toxicity Evaluation

MCHB-DL-TE (AMSAT-I-MEP/28 Apr 95) (40) 2d End Mr. Nelson/jls/DSN 584-3980  
SUBJECT: Surgeon General Toxicological Clearance for Electron® and Electron QED®

Commander, U.S. Army Center for Health Promotion and Preventive Medicine (Provisional),  
Aberdeen Proving Ground, MD 21010-5422 17 Aug 1995

FOR Commander, Headquarters, U.S. Army Materiel Command, ATTN: AMCSG-I, 5001  
Eisenhower Avenue, Alexandria, VA 22333-0001

1. References:

- a. Material Safety Data Sheet, Electron, Ecolink Inc., 1481 Rock Mountain Blvd, Stone Mountain, GA 30083.
- b. Material Safety Data Sheet, Electron QED, Ecolink Inc., 1481 Rock Mountain Blvd, Stone Mountain, GA 30083.
- c. National Library of Medicine, Registry of Toxic Effects of Chemical Substances (RTECS) database, National Library of Medicine, Bethesda, MD 20894.
- d. National Library of Medicine, Hazardous Substances Data Bank, (HSDB) database, National Library of Medicine, Bethesda, MD 20894.
- e. Data package, Ecolink Inc., 1481 Rock Mountain Blvd, Stone Mountain, GA 30083.
- f. Toxicological Assessment, Performance Products Group, EXXON Chemical Company, P.O. Box 3272, Houston, TX 77253-3272.
- g. 40 CFR Part 82, Protection of Stratospheric Ozone, Environmental Protection Agency, Washington, DC.

2. Conclusion and Recommendation. Toxicity Clearances are granted for Electron® and Electron QED® solvent cleaners within the context of the manufacturers recommendations for personal protective equipment and exposure limit of 300 ppm. These Toxicity Clearances are based on a review of the toxicity data and the intended use of these solvents. No additional testing is recommended.

3. Background. The U.S. Army Materiel Command Surgeon General has requested a Toxicity Clearance for Electron® and Electron QED®.

MCHB-DL-TE

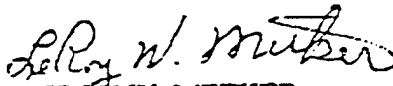
SUBJECT: Surgeon General Toxicological Clearance for Electron® and Electron QED®

a. Solvent cleaners such as trichloroethane and methyl ethyl ketone are currently used by the Army Aviation and Troop Command. These solvents are either listed by the EPA as ozone depleters that require an alternative, or have long term toxicity problems that may accrue to workers from potential exposures. Electron® and Electron QED® have an aliphatic hydrocarbon base and Electron QED® is a mixture with a terpene. The toxicity data for these two products have been reviewed (references 1a, c, d, e, f).

b. Hydrotreated heavy naphtha petroleum, a type used for the production of a Electron® and Electron QED®, is a complex combination of hydrocarbons in the C6 through C13 range. Acute toxicity testing includes oral, dermal and inhalation routes. Subchronic, mutagenicity and developmental toxicity testing have been performed. Terpenes are among the listed alternatives to solvents with ozone depletion potential (reference 1g). Following the manufacturers recommendations for personal protective equipment will preclude skin irritation and sensitization from terpenes that is possible in sensitive individuals.

FOR THE COMMANDER:

2 Encls  
wd all encls

  
LEROY W. METKER  
Program Manager  
Toxicity Evaluation

## Distribution List

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1 ATTN SMCAR ESC S  
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  - 1 HQ E CO 25TH AVIATION (SGT HEAD)
  - 1 HQ B CO MSB (CW2 PHIPPS)
- FORT DRUM NY 13602

CDR

HQ US ARMY ALASKA

FORT RICHARDSON (MR PENYAK)

- 1 600 Richardson Drive #5000
- Fort Richardson Alaska 99505-5000

CDR

OREGON AIR NATIONAL GUARD

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  - 1 142 MAS ANG (MR SMITH)
  - 1 142 MAS SQ/MAFAG (MR. KUTCHER)
  - 1 142 MAS/MAWR (MR. BECKER)
- 6801 NE CORNFOOT AVE  
PORTLAND OR 97218-2797

CDR

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- PO BOX 2003  
CONCORD NH 03202-2003

CDR

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- 1 EMC-C CAMP DODGE (MR SHROYER)
  - 1 GS MAINTENANCE CO (MR DAVIS)
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JOHNSON IA 50131-1902

CDR

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TRADOC  
DG/G5 MAITENANCE DIVISION

- 1 ATTN ATZK DLM (MR HAM)  
FORT KNOX KENTUCKY

CDR  
HQ US ARMY AVIATION & TROOP COMMAND  
MAINTENANCE DIRECTORATE

- 1 ATTN AMSAT-1-MEP  
4300 GOODFELLOW BLVD  
ST LOUIS MO 63120-1798

CDR  
CORPUS CHRISTI ARMY DEPOT  
DIR COMP PDN, WAV/COMM DIV

- 1 CODE: 5WL5, STOP 90 (Mr. Torres)  
CORPUS CHRISTI, TX 78419-5260

CDR  
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- 1 AVIATION SUPPORT FACILITY  
125 GOODRIDGE LANE  
WASHINGTON PA 15301-0020

CDR  
DELAWARE ARMY NATIONAL GUARD

- 1 ORGANIZATION MAINTENANCE SHOP #5 (MR BAKER)  
RD 2 BOX 214C  
DAGSBORO DELAWARE 19939-98021

CDR  
WASHINTON ARMY NATIONAL GUARD

- 1 MILITARY DEPARTMENT (MR DOSLAND)  
CAMP MURRAY  
TACOMA WASHINGTON 98430-5000

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FLEET ACTIVITIES CHINHAE

- 1 PSC 479 (MR HENDERSON)  
FPO-AP 96269-1100

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PO BOX 14587  
MADISON WI 53714-0587

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1 114FG LGQ (MSGT KREULEN)  
1201 W ALGONQUIN ST  
PO BOX 5044  
SIOUX FALLS SD 57117-5044

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1 104TH FIGHTER GROUP (SMSGT SANVILLE)  
BARNES MUNICIPAL AIRPORT  
WESTFIELD MA 01085-1385

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1 FACILITIES MANAGEMENT OFFICE (CPT GILMAN)  
5636 EAST MCDOWELL ROAD  
BUILDING 331  
PHOENIX AZ 85008-3495

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1 189 AG/MAFA (MR WILLIAMS)  
4600 VANDENBERG BLVD  
LITTLE ROCK AFB AR 72099-5065

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MONTANA ARMY NATIONAL GUARD  
1 DIRECT SUPPORT COBINED MAINTENANCE SHOP (MR SMITH)  
PO BOX 4789  
HELENA MT 59604-4789

CDR  
127TH F.W. SELFRIDGE ANGB  
1 ATTN MR NOWICKI  
MT CLEMENS MI 48045

CDR  
1 U.S.Army Environmental Center  
Environmental Technology Devision

Attn: Mr. Walker  
Bldg 440  
Abeending Proving Grounds, MD 21010-5401

CDR

- 1 U.S. Army Aberdeen Test Center  
ATTN: STEAC-EV (Mr. Bill Newton)  
400 Colleran Road  
Aberdeen Proving Ground, MD 21005-5059

CDR

- 1 Army Alanta Contracting Center  
ATTN: AFLG-PRC (Ms. Williams)  
Bldg 130  
ANDERSON WAY, FT. MCPHERSON, GA 30330-6000

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- 1 7th ARMY TRAINING COMMAND  
AMC-FAST SCIENCE AND TECHNOLOGY ADVISOR (Mr. Rees)  
ATTN: AEAGX-SA, APO AE 09014

CDR

- 1 III CORPS  
ATTN: AFZF-GL-T (Mr. Holley)  
BLDG. 1001 ROOM C325  
FT. HOOD, TX 76544-5056

CDR

- 1 1 CORPS & FORT LEWIS  
ATTN: AFZH-DEQ, MS17C (Ms. Trout)  
FT. LEWIS, WA 984-5000

**DEPARTMENT OF THE NAVY:**

CDR

- 1 NAVAL RSCH LABORATORY  
ATTN CODE 6176 (R. MOWERY)  
4555 OVERLOOK AVENUE, SW  
WASHINGTON DC 20032

CDR

NAVAL SEA SYSTEMS CMD

- 1 ATTN SEA 03M3  
2531 JEFFERSON DAVIS HWY  
ARLINGTON VA 22242-5160

CDR  
NAVAL SURFACE WARFARE CTR  
CARDEROCK DIVISION

- 2 ATTN CODE 632 (MS Wenzel)
- 1 ATTN CODE 859  
9500 MACARTHUR BLVD.  
WEST BETHESDA, MD 20817-5700

CDR  
NAVAL AVIATION DEPOT  
MATERIAL ENGINEERING

- 2 CODE: 4.3.4.2 (Ms. Grant)  
PSC Box 8021  
CHERRY POINT, NC 28533-0021

CDR  
NAVAL STATION MAYPORT

- 2 CODE: N4E9 (Mr. Tierney)  
SCE ENVIRONMENTAL  
P.O. BOX 280067  
MAYPORT, FL 32228-0067

CDR  
NSWCCD

- 1 CODE 631 (MR LUNDY)  
US NAVAL BASE BLDG 619  
PHILADELPHIA, PA 19112-5083

CDR  
NAVAIR AIR

- 1 4.3.4JEM (MR MULLER)  
1421 JEFFERSON DAVIS HIGHWAY  
ARINGTON, VA 22243

CDR  
Naval Aviation Depot North Island  
Bldg 469, Materials Engineering Lab

- 1 Code: 434  
San Diego, CA 92135-7058

CDR



1 NAVSEA  
CODE: 07E21 (Mr. Adams)  
2531 JEFFERSON DAVIS HIGHWAY  
ARLINGTON, VA 22242

1 CDR  
NAWC WARMINSTER  
CODE: 4.3.4.1 (Mr. Bevilacqua)  
WARMINSTER, PA 18974-0591

1 CDR  
NAVAL AVIATION DEPOT, MCAS  
CODE: 4.3.4.2 (Mr. Cahoon)  
BLDG. 4032  
CHERRY POINT, NC 28533

1 CDR  
NAVY ENVIRONMENTAL HEALTH CENTER  
2510 WALMER AVE (Mr. Drewyer)  
NORFOLK, VA 23513-2617

1 CDR  
NAVAL WARFARE SYSTEMS COMMAND  
CODE: 10-11E (Mr. Gentilcore)  
2451 CRYSTAL DRIVE  
ARLINGTON, VA 22245-5200

1 CDR  
COMNAVSURFLANT  
Code: N411D  
1450 MITSCHER AVE.  
NORFOLK, VA 23551-2494

1 CDR  
NSWCCD  
Code 1413 (Mr. Kollar)  
PHILADELPHIA Naval BASE  
PHILADELPHIA, PA 19112

1 CDR  
NAVSEA  
CODE: 00T4 (Dr. McCray)  
2531 JEFFERSON DAVIS HIGHWAY  
ARLINGTON, VA 22242

CDR  
NAVAIR  
1 CODE: 3.6.1.2 (Mr. Quist)  
1421 JEFFERSON DAVIS HIGHWAY  
ARLINGTON, VA 22243

CDR  
NADEP JACKSONVILLE  
1 CODE: 343 (Rossi)  
NAS  
JACKSONVILLE, FL 32212-0016

CDR  
NSWCCD  
1 CODE 631 (Ruparelia)  
BLDG. 619  
PHILADELPHIA, PA 19112-5083

CDR  
NAVY SPCC  
1 CODE: 0541.5 (Mr. Sieger)  
5450 CARLISLE PIKE  
MECHANICSBURG, PA 17055-0788

CDR  
NAVAL SEA SYSTEMS COMMAND  
1 CODE: sea 00TB  
2531 JEFFERSON DAVIS HWY.  
ARLINGTON, VA 22242-5160

**DEPARTMENT OF THE NAVY/U.S MARINE CORPS:**

1 PROG MGR COMBAT SER SPT  
MARINE CORPS SYS CMD  
2033 BARNETT AVE STE 315  
QUANTICO VA 22134-5080

CDR  
MARINE CORPS LOGISTICS BA  
1 ATTN CODE 837  
1 ATTN CODE 883  
814 RADFORD BLVD  
ALBANY GA 31704

CDR  
BLOUNT ISLAND CMD

- 1 ATTN CODE 922/1  
JACKSONVILLE FL 32226-3404

CDR  
MARINE CORPS LOGISTICS BA  
1 ATTN CODE B880 (MR MSRTEL)  
BARSTOW CA 92311-5015

**DEPARTMENT OF AIR FORCE:**

- 1 AIR FORCE WRIGHT LAB  
ATTN WL/POSL  
1790 LOOP RD N  
WRIGHT PATTERSON AFB  
OH 45433-7103

- 1 AIR FORCE WRIGHT LAB  
ATTN WL/MLBT  
2941 P ST STE 1  
WRIGHT PATTERSON AFB  
OH 45433-7718

- 1 AIR FORCE WRIGHT LAB  
ATTN WL/MLSE  
2179 12TH ST STE 1  
WRIGHT PATTERSON AFB  
OH 45433-7718

- 1 WR ALC/LVRS  
225 OCMULGEE CT  
ROBINS AFB  
GA 31098-1647

- 1 SAN ANTONIO AIR LOGISTICS CENTER  
SA-ALC/TIESM
- 1 SA-ALC/TIEM (Mr. Baggett)  
450 QUENTION ROOSEVELT ROAD  
KELLY AFB, TX 78241

**DEPARTMENT OF DEFENSE:**

- DEFENSE SUPPLY Center Richmond
- 1 ATTN DSCR SSA
- 1 ATTN DSCR STA
- 2 ATTN DSCR VBB
- 8000 JEFFERSON DAVIS HWY
- RICHMOND VA 23297-5000
  
- 1 DEFENSE TECH INFO CTR
- 8725 JOHN J. KINGMAN RD.
- SUITE 0944
- FORT BELVOIR VA 22060-6210